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HEALTH AND MORTALITY IN LOUISIANA

By

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LOUISIANA STATE UNIVERSITY
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HEALTH AND MORTALITY IN LOUISIANA

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I SUMMARY

Diseases of the heart are far out ahead among all the causes of death in Louisiana. Each year they claim around 6,000 of the state's citizens, killing people at the rate of more than 250 per 100,000 population.

Pneumonia and influenza, nephritis, cancer, diseases of the nervous system, tuberculosis, accidents other than those in which motor vehicles are involved, causes associated with premature birth, syphilis, and motor vehicle accidents, in the order named, also are included among the ten leading causes of death in the state. Together these ten categories account for three fourths of all the deaths that occur annually.

Louisiana's farms enjoy a definite advantage over its towns and cities from the standpoint of health and longevity. This is true for both whites and Negroes and for practically all age groups. The rural people of the state are less likely to be decimated by contagious diseases, fall by the way because of degenerative ailments, or lose their lives by accident or through violence than their fellows in the towns and cities. However, malaria, typhoid fever, whooping cough, diphtheria and pellagra take a proportionately higher toll of life in rural than in urban areas.

Louisiana Negroes have much higher mortality rates than their white fellows. The racial differences are greatest in infancy, and have largely disappeared by the time age 65 has been reached. Syphilis, pellagra, typhoid fever, homicide, whooping cough, malaria, deaths associated with childbirth, tuberculosis, pneumonia and influenza and diarrhea all are included in the list of these in which the death rate of Negroes is more than twice that of whites. However, Negroes are much less likely to die in motor vehicle accidents or by self destruction than are the white people of Louisiana.

Louisiana compares unfavorably with the nation in the control of transmissible diseases. Among both whites and Negroes, rural and urban, the death rates from most of the important diseases of this type are above those for the nation. However, up until the present time the various causes of death that are associated with old age and the degeneration of the body do not claim as many persons in Louisiana per 100,000 population as they do in the nation as a whole.

Health in the state is improving rapidly. In 1940 the mortality rates from pneumonia and influenza, tuberculosis, typhoid fever, malaria, diphtheria, and most other contagious diseases, were only fractions of what they were in 1920. Deaths associated with childbirth and homicides also are rapidly declining. Pellagra and other deficiency diseases are being reduced greatly. However, such ailments as heart disease, cancer, diabetes, and ulcers of the stomach are mounting fast among the causes of death. Motor vehicle accidents and suicide were also taking a much larger toll in 1940 than they were in 1920.

The saving in life achieved during the period 1920 to 1940 was much greater, relatively, among the Negro than among the white population of the state. For nearly all of the important causes of death the rates for the two races were much nearer one another at the close of the period than they were at the beginning.

Louisiana has hardly kept pace with the nation in the control of transmissible diseases, but the state has maintained its favorable position with respect to mortality from most of the degenerative causes of death.

II INTRODUCTION

A. Importance of Health Studies

Good health is one of the most fundamental goals of all efforts to improve human welfare. Agriculture and home economics, as well as the medical and sanitary sciences, are to be judged by the extent to which they contribute to a longer and more healthful life for the population.

In time of war the health status of the population assumes an increased importance. On the home front illnesses and accidents result in absenteeism in industrial plants which are producing vital war materials. Such lowered efficiency is likely to impair the whole war effort. Those responsible for the recruiting of military manpower are likewise concerned by the large numbers of draftees who must be rejected for physical impairments. The nation can ill afford to spare a considerable share of its young men from military service on the basis of ill-health, nor can any portion of the nation afford to fall down in contributing its quota to the sum total of those engaged in all phases of national defense.

In war or in peace more systematized factual knowledge concerning the health situation at a given time, and the direction in which we are moving, is an important practical portion of science. Its worth is especially great for the direction and guidance of activity programs in education, sanitation, nutrition, and so forth which are designed to make for more healthy living and for longer life.

B. Objectives

Two sets of objectives were before us constantly in planning and executing this study. In the first place, we wanted accurate information concerning the principal causes of death, and the relative importance of each. We desired to know how these varied according to race, and especially how the rural population compared with the urban in resisting each of them. For all of the items included in the first set of objectives we wished to know how Louisiana compared with the nation.

The second set of objectives involved the time factor—we wanted to know the trends. First, of course, came the determination of the movement of each of the principal selected causes of death, along with changes in the death rate generally. But we also wanted to observe the changes with the data properly subdivided according to race. (Had it been possible we also would have liked to compare changes in rural and urban areas.) Finally, we especially desired to see the extent to which Louisiana has been keeping pace with, exceeding, or falling behind the nation as a whole in the control of mortality generally, and of each of the specific causes of death.

C. Data and Procedures

The index to health and mortality used in this study is the death rate. It is obtained by relating the number of deaths which occur in a given year to the population. Such an index may be used to represent the proportional parts of the total population, or of classes within the population, which are lost each year from all and from specific causes of death.

The basic element in the computation of the death rate is the number of deaths. Publications of the Division of Vital Statistics of the United States Bureau of the Census[1] contain information on numbers of deaths which occurred in the state for each year beginning with 1918, or since Louisiana began to register a sufficient proportion of her deaths to qualify for inclusion in the Registration Area of the United States. These deaths are classified by cause, according to a system known as the International List of Causes of Death. However, the List has been revised periodically to keep it abreast of new developments in the field of medical science, and the information for most of the diseases is not comparable over the entire period. There have been three revisions since 1918, with the result that some of the titles have been dropped, others added, and still others shifted from one grouping to another. The numbers included under the various titles were shifted, and were made comparable to those used in the 1938, or most recent, revision of the List.[2]

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[1] Those most useful are: *Mortality Statistics,* for the years 1920-1936, inclusive; *Vital Statistics of the United States,* for the years 1936-1940, inclusive; *Vital Statistics — Special Reports;* and a volume by Forrest E. Linder and Robert D. Grove entitled *Vital Statistics Rates in the United States,* 1900-1940. All of these are publications of the United States Bureau of the Census and are printed by the Government Printing Office, Washington, D. C.

The number of people in the population is the second item necessary for the calculation of the death rate. Since deaths are recorded on an annual basis it is desirable to relate them to the population at the midpoint of the period over which deaths are tabulated, and, if trends are to be reflected, it is necessary to estimate the population for the years between the enumerations made each decade by the United States Census. The method of simple arithmetic linear interpolation has been employed in estimating the population of Louisiana and its subdivisions.[3]

Using the population of Louisiana as of July 1, 1940, and the number of deaths from each cause as classified by the International List of Causes of Death, specific death rates per 100,000 of the state's population were computed. Of these, 25 causes were selected for further study. These include all the major causes, or those which levied tolls as high as 10 deaths against each 100,000 of the population of the state in 1940. Quite naturally, they include representations of three general classes of causes of death: (1) the degenerative diseases, or those associated with advancing age; (2) the transmissible, or contagious diseases; and (3) external causes of death. For all 25 categories the data for further analysis by race and residence in the state and nation are available in 1940, and can be made comparable on an annual basis since 1920, by race.

The numbers of deaths which occurred in Louisiana from the 25 causes are available by residence, and rates of mortality were computed separately for rural and for urban areas in the state in 1940.[4]

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[2] Since International List numbers as well as names of the diseases are available for the successive revisions, it was possible to work out a key list, which was used to arrive at annual numbers of deaths from most of the causes which are essentially comparable since 1920. Such a key list was later published in *Vital Statistics Rates in the United States,* 1900-1940, p. 105.

[3] This method was selected after a comparison was made of the results obtained by application of the arithmetic interpolation and the geometric, and the method used by the United States Bureau of the Census. When applied to the Louisiana population for the period 1920-1940, the estimates derived by simple linear interpolation more closely approached the estimates as published by the Census, but at the same time avoided certain extreme variations in the rate of annual population growth in the period — variations which cast some doubt on the accuracy of the latter method.

[4] The 1940 death data by residence are by far the most satisfactory for comparative purposes, because prior to that year the deaths were allocated by place of occurence of the death rather than by usual place of residence of the deceased, a practice which minimizes rural and exaggerates urban rates because of the concentration of hospitals and other medical

For this purpose the definitions of "rural" and "urban" adopted are those commonly employed by the United States Bureau of the Census; that is, all persons living in incorporated centers of population of 2500 and above are designated as "urban," the remainder of the state as "rural." The two types of areas were compared with respect to mortality rates from the 25 causes of death.

Numbers of deaths are also available by cause for the two major racial groups. Rates were computed for "whites" and for "all other races" on an annual basis from 1920 to 1940, and the racial groups were further subdivided by residence for the year 1940. The terms "Negro," "colored," and "nonwhite" are used synonomously, as Negroes constitute the bulk of all nonwhites in the state.

Rates of death were computed for racial and residential groups in the nation as a whole in 1940, for specific causes of death, and those which prevailed in Louisiana compared with those found to exist in the nation.

Annual rates of death were plotted by race for the 25 causes of death for the period 1920 to 1940 in Louisiana in order to determine the trends in rates of death from each of the causes.[5]

Trends which were found to exist in Louisiana were compared with those which took place in the nation as a whole over the same period by cause of death. The area chosen to represent the nation in this case is the Registration Area as of 1920, which includes 34 states and the District of Columbia. This was done in order to have a constant area in which trends could be reflected, for only in 1933 were all of the 48 states at last included in the Death Registration Area.

III WHAT KILLS LOUISIANIANS

A. Causes of Death

In 1940, 25,648 persons died in Louisiana. This is 10.8 per each 1000 of the population. The total includes deaths from various kinds of illnesses, those brought about by accidental or other violent means, and those for which the causes were unknown or ill-defined.

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facilities in the cities. Although the discussion is based primarily on differences found to exist in 1940, these differences are generally substantiated when mortality rates are compared biannually for the decade 1930-1940, or the period for which numbers of deaths are available for centers of population under 2500. Variations are wider, as would be expected, throughout the period over which deaths were registered by place of occurrence.

[5] We were not successful in our various attempts to make a comparison of trends by residence. Rates of death which were computed for rural and urban areas in the 1930-1939 period differed considerably from those after 1939, or when the basis of allocation was changed from occurrence to residence. More error was introduced by the factor for some of the causes than for others. Then, population estimates for inter-census years for rural and urban areas are inadequate for year-to-year comparison of trends. Finally, if comparisions are extended back beyond 1930, the definition of "urban" would have to be changed, because of the way in which deaths were tabulated, to include cities of 10,000 population and over, instead of 2500 or more.

In terms of the number of lives which they claim annually, some of the causes are vastly more important than others. The heaviest toll of all is exacted by heart disease, which stands far out in front of any of the rest in this respect and alone accounts for almost one fourth (23.6 per cent in 1940) of all deaths that occur in the state. It killed in 1940 no less than 6,066 persons, or about 256 of every 100,000 of the state's population. More than twice as many people died, in fact, from heart disease than from any other one cause.

Standing in second place as a killer of Louisiana's people is pneumonia and influenza which, combined, are responsible for 107 deaths per 100,000 of the population and account for about 10 per cent of the annual death toll. In third and fourth places on the list of diseases which prove fatal to the people of the state are nephritis and cancer, which are of about the same importance, killing 91.5 and 87.4 persons, respectively, per 100,000 of the population in 1940. These two diseases each account for an additional eight per cent of the total number of deaths. Only slightly less likely to be fatal are diseases of the nervous system,[6] to which were attributed 70.4 deaths for each 100,000 residents of the state.

Sixth in rank on the list of fatal diseases is the traditionally dreaded killer, tuberculosis. Almost 60 persons per 100,000 of the population succumb annually to this disease in Louisiana. About 45 Louisianians meet their deaths by accidents other than those in which motor vehicles are involved and about 37 because of premature birth. Nearly 30 per 100,000 die with syphilis as the primary cause. Motor vehicle accidents, a cause which has attracted much attention in recent years, was responsible for slightly less than 25 deaths for each 100,000 Louisianians in 1940 and stands in tenth place in relation to the other important causes of death. The foregoing constitute the ten principal diseases and conditions leading to loss of life in Louisiana, and these, together, account for approximately three fourths of the entire annual death toll.

In addition, there are other diseases of sufficient importance to merit the serious consideration of those concerned with health conditions in the state. Among these are diarrhea, diabetes, homicide, puerperal causes, and hernia, each responsible for between 200 and 400 deaths each year, or from 10 to 20 deaths per 100,000 persons. (See Table I.) Annually between six and ten people out of each 100,000 are dying from appendicitis, from cirrhosis of the liver, congenital malformations, suicide, whooping cough, and ulcer of the stomach.

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[6] The title "diseases of the nervous system" as used in this study refers only to intracranial lesions of vascular origin, which constitute the majority of diseases which affect the nervous system.

There are still other diseases which formerly were of considerable importance and which by 1940 were still killing from two to between three and four persons per 100,000 of the population. Examples of these are malaria, typhoid fever, pellagra, and diphtheria.

Observation of the relative importance of the various causes of death in Table I makes it evident that the degenerative diseases, which take such a heavy toll of persons in middle and late life, rank high. Diseases of the heart, cancer, and diseases of the nervous system occupy very prominent places; and these four, when combined with the respiratory ailments and with accidents account for about 80 per cent of all deaths. At the other end of the scale fall many of the infectious diseases—typhoid fever, whooping cough, diphtheria—from which loss of life is now relatively low in comparison with the total number of deaths. As will be indicated later, Louisiana has done much to control mortality from infectious diseases; but it is still confronted with the greater task of reducing fatalities from degenerative ailments, accidents, and violence.

TABLE I

Mortality Rates from the Common Causes of Death in Louisiana, 1940, and the Relative Rank of Each Cause*

Rank	Cause of Death	Rate per 100,000 Population
	All causes	1082.0
1	Diseases of the heart	256.0
2	Pneumonia and influenza	106.9
3	Nephritis	91.5
4	Cancer and other maligant tumors	87.4
5	Diseases of the nervous system	70.4
6	Tuberculosis	58.7
7	Accidents other than motor vehicle	44.7
8	Premature birth	36.9
9	Syphilis	29.1
10	Motor vehicle accidents	24.1
11	Diarrhea, enteritis, ulceration of the intestines	17.6
12	Diabetes mellitus	17.4
13	Homicide	12.0
14	Puerperal causes	11.5
15	Hernia, intestinal obstructions	10.1
16	Appendicitis	9.7
17	Cirrhosis of the liver	8.9
18	Congenital malformations	8.8
19	Suicide	8.5
20	Whooping cough	6.3
21	Ulcer of the stomach	6.1
22	Malaria	3.7
23	Typhoid and parathphoid fever	3.4
24	Pellagra (except alcoholic)	3.2
25	Diphtheria	2.1
	Ill-defined causes	12.4
	All other causes	147.0

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*Based on population estimated as of July 1, 1940.

B. Residential Differences.

Louisiana's farms enjoy a definite advantage over its towns and cities from the standpoint of health and longevity. The annual death toll from all causes is only 8.7 per 1000 in the rural areas of the state in comparison with 13.7 in the urban districts. The differential is favorable to the rural population in the cases of both whites and Negroes, and it applies at all ages except those of early childhood and young adulthood when the rates are very near one another. (See Figure 1.) The country makes the best showing in comparison with the city in the health and consequent low death rates of infants and old people. Although the rural white people have much lower death rates than their urban fellows, the advantage is not so striking among the white people as it is among the nonwhite or Negro population.

Within the urban group the highest rates of all were characteristic of the smaller cities, or those ranging in population from 2500 to 10,000.

As would be expected on the basis of these death rates, Louisiana's rural people (those living in centers of less than 2500 population and the open country) demonstrate a greater resistance to most of the important causes of death than do residents of the towns and cities of the state. (See Table II.)

This is true without exception of the degenerative diseases. It is especially marked with respect to mortality among the white population, for whom differences between rural and urban areas are greater for diseases of this type than they are for nonwhites. Thus deaths from heart disease were twice as frequent relatively among urban whites as among rural whites in 1940, and the proportion of urban colored who succumbed to these diseases exceeded the proportion of rural colored by 60 per cent. The country enjoyed about the same advantage over the city in regard to deaths from nephritis, the racial differences also being of the same order. Cancer was about twice as likely to be fatal to urban as to rural residents, and the same is true of diabetes. Mortality rates from diseases of the nervous system were about 50 per cent higher for urban residents, and those from ulcer of the stomach one third higher. Appendicitis rates are about 80 per cent higher among urban residents of both races, and hernia and cirrhosis of the liver are likewise more important as causes of death in cities. Thus the country people, both white and Negro, enjoy a great advantage over urban Louisianians regarding susceptibility to degenerative ailments. This is all the more significant due to the fact that the country has more than its pro rata share of the state's old people, among whom the degenerative troubles are the principal causes of death.

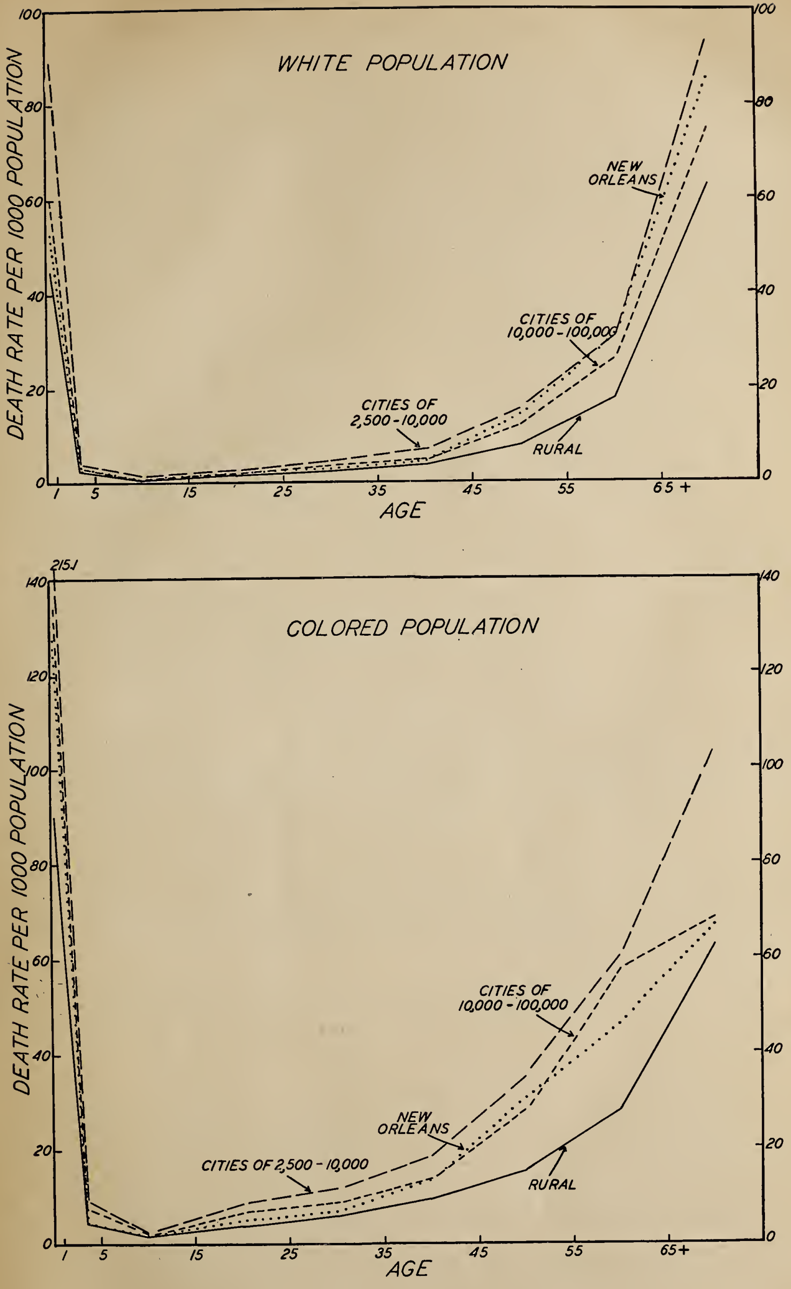

Figure 1. Death Rates From All Causes For Selected Residential Groups, Louisiana, 1940, by Age and Race.

The rural sections of the state also are better off than the urban in respect to deaths from many of the important transmissible diseases. Syphilis, one of the more common ones, is strikingly more likely to be fatal to urban residents. In fact, in relation to the population, urban whites are 3.4 times as likely to die of syphilis as are rural whites; and urban colored people are almost twice as likely to die of this dread diseases as their fellows in the rural districts. The diseases which primarily affect the respiratory tract take much heavier tolls from the populations of cities, and especially from the colored segments of city populations. According to the data, tuberculosis annually kills 41 out of each 100,000 rural residents and 77 of each 100,000 urban residents of Louisiana. In 1940 the rural and urban death rates of white people from this disease were 25.5 and 46.9, respectively, and those for colored people were 66.4 in the rural and 141.6 in the urban areas. Pneumonia and influenza, which are a little more likely to be fatal to urban whites than to rural, are characterized by rates about 60 per cent higher among colored people who live in towns and cities than among those who reside in the country.

Deaths from causes associated with premature birth seem to occur more commonly in urban areas especially among nonwhites, although a part of the difference is probably due to better registration in the cities.

More urban than rural residents die from violent or accidental causes. For example, the suicide rate is more than twice as high in the city as in the country, and this is true for both whites and Negroes. Homicide, particularly among colored people, is much more frequently a cause of death in urban areas. And accidents, both those in which motor vehicles are involved and those of other types, consistently kill somewhat higher proportions of the populations of cities than of the country people.

Residence seems to exert little influence on the frequency with which deaths occur due to puerperal causes, congenital malformations, and diarrhea.

But there are some causes of death for which the city makes a better showing than the country. Among colored people the death rates in 1940 from typhoid fever and whooping cough in rural areas exceeded somewhat those in urban areas. The same holds true for pellagra and diphtheria, and for both of them the differential applies to the white population also. Malaria, of all the important causes of death, however, constitutes the most clearcut exception to the rule of higher rates in urban Louisiana. As in the past, this disease continues to be a greater danger to health and life in the country than in the city.

TABLE II

Mortality Rates from the Common Causes of Death in Louisiana, 1940, by Residence and Race*

Cause of death	Rates per 100,000 population								
	Total			White			Colored		
	Rural	Urban	Ratio: Urban-Rural	Rural	Urban	Ratio: Urban-Rural	Rural	Urban	Ratio: Urban-Rural
Diseases of the heart	188.7	351.1	1.9	162.5	340.2	2.1	230.1	374.0	1.6
Pneumonia and influenza	96.3	121.6	1.3	76.3	81.7	1.1	127.9	205.7	1.6
Nephritis	70.3	120.7	1.7	51.5	99.0	1.9	99.8	166.4	1.7
Cancer	61.1	124.5	2.0	60.4	124.7	2.1	62.2	124.1	2.0
Diseases of the nervous system	58.4	87.1	1.5	46.4	71.5	1.5	77.3	120.0	1.5
Tuberculosis	41.4	77.3	1.9	25.5	46.9	1.8	66.4	141.6	2.1
Accidents other than motor vehicle	41.0	51.0	1.2	36.3	43.9	1.2	48.4	66.0	1.4
Premature birth	31.3	55.4	1.8	24.5	31.7	1.3	42.1	105.4	2.5
Syphilis	21.7	39.3	1.8	4.6	15.5	3.4	48.6	89.5	1.8
Motor vehicle accidents	19.6	29.1	1.5	22.6	31.7	1.4	14.9	23.5	1.6
Diarrhea, enteritis, etc.	13.0	13.6	1.0	7.4	7.8	1.0	21.8	25.7	1.2
Diabetes mellitus	12.1	25.1	2.1	12.2	28.1	2.3	12.1	18.7	1.5
Homicide	8.6	16.3	1.9	4.6	6.0	1.3	14.9	38.1	2.6
Puerperal causes	11.8	11.0	.9	7.0	7.2	1.0	19.5	19.0	1.0
Hernia	7.8	13.2	1.7	6.7	11.4	1.7	9.5	16.8	1.8
Appendicitis	7.3	13.3	1.8	7.3	13.4	1.8	7.3	13.0	1.8
Cirrhosis of the liver	5.1	14.3	2.8	5.8	15.3	2.6	3.9	12.1	3.1
Congenital malformations	7.9	9.8	1.2	8.1	10.7	1.3	7.6	7.9	1.0
Suicide	5.6	13.3	2.4	8.3	18.2	2.2	1.3	2.8	2.1
Whooping cough	7.9	4.2	.5	2.9	3.3	1.1	15.6	6.0	.4
Ulcer of the stomach	5.1	7.0	1.4	5.3	7.2	1.4	4.9	6.7	1.4
Malaria	5.1	1.7	.3	3.3	.9	.3	7.8	3.5	.4
Typhoid and paratyphoid fever	3.7	3.1	.8	1.6	1.8	1.1	6.9	5.7	.8
Pellagra	3.7	2.3	.6	1.1	1.0	.9	7.8	5.1	.6
Diphtheria	2.5	1.5	.6	2.0	1.6	.8	3.2	1.3	.4
All causes	874.7	1370.9	1.6	706.5	1171.2	1.7	1139.7	1792.8	1.5

*Based on population enumerated as of April 1, 1940.

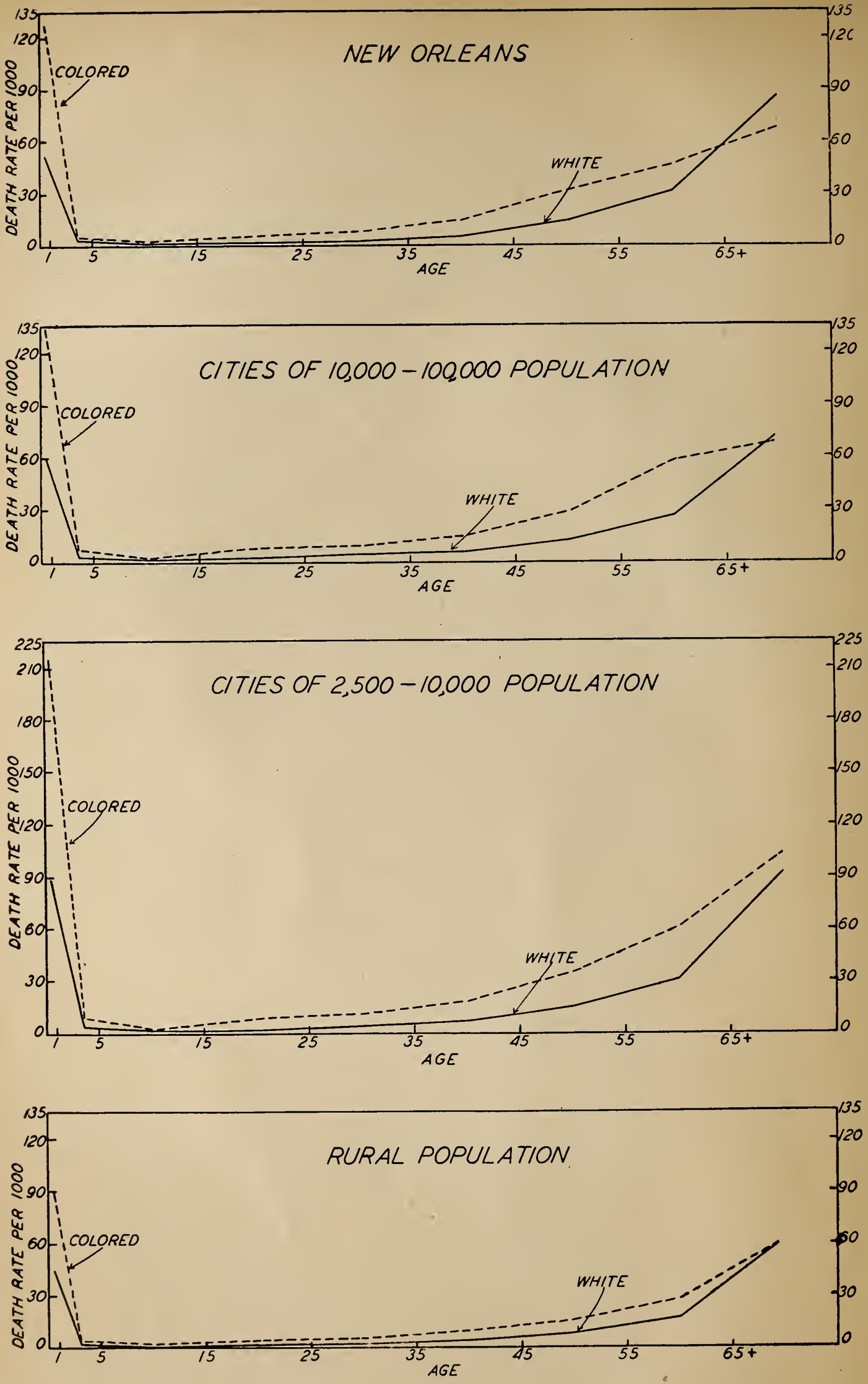

Figure 2. Death Rates From All Causes For White and Colored Populations, Louisiana, 1940 by Age and Residence.

C. Racial Differences.

The health of Louisiana's colored people, as gauged by mortality rates, is considerably worse than that of her white people. The number of deaths from all causes for this race is about 13.8 per 1000, or one and one-half times as high as that of whites (9.1 per 1000). The whites enjoy this superiority over nonwhites at all ages except 65 years and above; and the differences in favor of the whites persist in all types of residential areas—in rural districts, in small and large cities—a fact which further substantiates their significance. (See Figure 2.)

The most extreme differences between the two races occur with respect to deaths among infants, indicating that the whites utilize superior skills and resources in caring for and feeding young children. After lethal selection has been operative for some years, the superiority of the whites decreases, and after age 65 the colored people of the State may enjoy a longevity which compares favorably with that of their white fellows. The reported data indicate this to be true in the large cities of the state. In rural areas, however, rates of death for colored and white persons beyond the age of 65 years are very close to each other, and in the small towns and cities (2,500 to 10,000 population) aged as well as younger Negroes are characterized by higher rates of mortality than are the whites who live there. But caution should be used in reaching conclusions on this score. It should be remembered that the age data for Negroes are less reliable than those for whites; and that the Social Security Program introduced between 1930 and 1940 may have stimulated some persons to attain the age 65 more quickly than normal. At any rate there were reported in Louisiana only 8,999 Negro females aged 55-59 in 1930 in comparison with 10,341 aged 65-69 in 1940. Also the decrease of Negro males in the age group under consideration from 11,099 aged 55-59 in 1930 to 10,417 aged 65-69 in 1940 does not seem sufficiently large. Among white females the corresponding change was from 19,032 in 1930 to 17,108 in 1940, and among white males the decrease was from 19,980 at the beginning of the decade to 15,744 at the close. Thus the apparent slight advantage of the nonwhites aged 65 and over in reality probably is due to the reduction in rate achieved by inflating the population.

Interestingly enough, with the age factors properly evaluated, it is in the small towns and cities (2500 to 10,000) that the differential between whites and Negroes is most pronounced. It will be remembered that these small centers are the ones where health and longevity seem to be the poorest in the state. Probably selective migration from the farms, the tendency for aged and ailing persons from the open country to move into the near-by center, is the responsible factor. If so, the tendency seems to be more pronounced among Negroes than among whites.

Louisiana's white people consistently make a better showing than her colored people in resisting many of the specific causes of death. (See Table III.) Differences in rates of mortality of the two races from the transmissible diseases are especially pronounced. Pneumonia and influenza are killing twice as many Negroes as whites in proportion to their respective numbers in the state; tuberculosis is taking a toll of colored lives two and one-half times as high as that of whites; and syphilis actually seems to be six and one-half times as deadly to the Negroes as to white residents of the state. Extreme differences also characterize the rates of death for the two races with respect to typhoid fever and whooping cough, each proving almost four times as likely to be fatal to Negroes as to whites. Malaria kills almost three times as many colored people, proportionate to population, and diarrhea is about twice as likely to be fatal to colored as to white residents. The rate of death from diphtheria for the colored population in 1940 slightly exceeded that for whites, but this has not been consistently true over a period of time in the past. This indicates that measures for the control of acute and infectious diseases which have been fairly successfully applied to whites need to be extended in a more efficient manner to the Negro population. If for no other reason, self-defense urges this upon the white population of the state.

There are other causes of death which rank right along with those of a transmissible nature in being more likely to be deadly to the Negroes of the state. Pellagra, a deficiency disease associated with poverty and poor food habits is, like syphilis, six times as likely to be fatal to Negroes as to white people. In proportion to their numbers colored people succumb almost three times as frequently to puerperal causes and almost twice as frequently to causes associated with premature birth as do whites.

On a percentage basis whites less frequently are involved in fatal accidents other than those with motor vehicles than are Negroes. Homicide is the cause of many more deaths among Negroes than among whites per 1,000 of the population, the rate for the former being more than four times that for the latter.

With respect to deaths from some of the degenerative diseases, whites also maintain an edge over nonwhites. Although it is the primary cause of death for both races, the death rate from diseases of the heart proved about 20 per cent higher among colored people than whites in 1940. The percentages of Negroes who succumb to nephritis and to diseases of the nervous system exceeded by about two thirds those of the whites who die of these diseases. Hernia, too, seems to be a little more likely to be fatal to Negroes than to whites.

TABLE III

Mortality Rates from the Common Causes of Death in Louisiana, 1940, by Race and Residence

Cause of death	Rates per 100,000 population Total*			Urban†			Rural†		
	White	Colored	Ratio: Colored-White	White	Colored	Ratio: Colored-White	White	Colored	Ratio: Colored-White
Diseases of the heart	239.7	284.6	1.2	340.2	374.0	1.1	162.5	230.1	1.4
Pneumonia and influenza	79.1	156.3	2.0	81.7	205.7	2.5	76.3	127.9	1.7
Nephritis	72.7	124.8	1.7	99.0	166.4	1.7	51.5	99.8	1.9
Cancer	88.7	85.1	1.0	124.7	124.1	1.0	60.4	62.2	1.0
Diseases of the nervous system	57.5	93.2	1.6	71.5	120.0	1.7	46.4	77.3	1.7
Tuberculosis	38.2	95.0	2.5	46.9	141.6	3.0	25.5	66.4	2.6
Accidents other than motor vehicle	40.8	51.5	1.3	43.9	66.0	1.5	36.3	48.4	1.3
Premature birth	27.6	53.6	1.9	31.7	105.4	3.3	24.5	42.1	1.7
Syphilis	9.8	63.6	6.5	15.5	89.5	5.8	4.6	48.6	10.6
Motor vehicle accidents	27.8	17.6	.6	31.7	23.5	.7	22.6	14.9	.7
Diarrhea, enteritis, etc.	12.9	25.9	2.0	7.8	25.7	3.3	7.4	21.8	2.9
Diabetes	19.1	14.4	.7	28.1	18.7	.7	12.2	12.1	1.0
Homicide	5.5	23.5	4.3	6.0	38.1	6.3	4.6	14.9	3.2
Puerperal causes	7.0	19.3	2.8	7.2	19.0	2.6	7.0	19.5	.8
Hernia	9.0	12.1	1.3	11.4	16.8	1.5	6.7	9.5	1.4
Appendicitis	9.9	9.2	.9	13.4	13.0	1.0	7.3	7.3	1.0
Cirrhosis of the liver	10.1	6.9	.7	15.3	12.1	.8	5.8	3.9	.7
Congenital malformations	9.4	7.7	.8	10.7	7.9	.7	8.1	7.6	.9
Suicide	12.3	1.8	.1	18.2	2.8	.1	8.3	1.3	.2
Whooping cough	3.1	12.1	3.9	3.3	6.0	1.8	2.9	15.6	5.4
Ulcer of the stomach	6.3	5.6	.9	7.2	6.7	.9	5.3	4.9	.9
Malaria	2.3	6.2	2.7	.9	3.5	3.9	3.3	7.8	2.4
Typhoid and paratyphoid fever	1.7	6.4	3.8	1.8	5.7	3.2	1.6	6.9	4.3
Pellagra	1.1	6.8	6.2	1.0	5.1	5.1	1.1	7.8	7.1
Diphtheria	1.9	2.5	1.3	1.6	1.3	.8	2.0	3.2	1.6
All causes	**914.9**	**1378.8**	**1.5**	**1171.2**	**1792.8**	**1.5**	706.5	1139.7	1.6

*Based on population estimated as of July 1, 1940.
†Based on population enumerated as of April 1, 1940.

In all, 17 of the 25 common causes of death strikes harder among the colored population of the state. Furthermore, all of these except diphtheria prove to be a greater menace to health and life of Negroes, whether they live in the towns and cities of the state, or in its country districts. Diphtheria, although it too proves more likely to be fatal to rural Negroes than to rural whites, seemed a little less so to colored than to white residents of cities in 1940.

Some of the causes of death kill about the same proportions of both races throughout the state. This is true of cancer, appendicitis, diabetes, and congenital malformations. The differences between white and colored death rates from ulcer of the stomach and from cirrhosis of the liver are likewise very small, although the latter seems very slightly more dangerous to white people.

There are two outstanding exceptions to the rule that larger proportions of Negroes than of whites succumb to each of the assignable causes of death. As is to be expected, motor vehicle accidents take a larger toll of whites in proportion to population than of Negroes; and relatively fewer colored persons are impelled to deliberate self-destruction. For every 100 white deaths proportionate to the population which are brought about by motor vehicle accidents there are only 63 colored deaths; and white people are seven times more prone to commit suicide than the Negroes. The wide differences between whites and colored persist in country as well as city populations, a fact which adds strong support to the validity of the findings.

D. Comparison wtih the Nation

Louisiana compares unfavorably with the nation in the control of transmissible diseases. In Louisiana both whites and Negroes, rural as well as urban, are more likely to be decimated by the contagious diseases than are their fellows in the United States as a whole. For example, in 1940 influenza and pneumonia killed more people in the state, relative to population, than in the nation, a differential true for the white and Negro, in both the rural and urban segments of the population. Most unfavorable of all is the showing of Negroes in the cities and towns of the state. (See Table IV.)

Similar is the situation in respect to most other transmissible causes of death. Higher rates of death from whooping cough, from typhoid fever, from diarrhea, and from diphtheria prevail in Louisiana than in the United States as a whole, the differential holding for whites and Negroes in rural as well as in urban areas. Tuberculosis, too, is more likely to be fatal to urban Louisianians than to city dwellers generally. As is the case with pneumonia and influenza, the colored residents of the state's cities make the poorest showing in this respect.

TABLE IV

Mortality Rates from the Common Causes of Death, Louisiana and the United States, 1940, by Race and Residence*

Cause of death	Rates per 100,000 population							
	Rural				Urban			
	White		Colored		White		Colored	
	La.	U.S.	La.	U.S.	La.	U.S.	La.	U.S.
Diseases of the heart	162.5	243.6	230.1	187.3	340.2	337.5	374.0	314.8
Pneumonia and influenza	76.3	70.0	127.9	117.6	81.7	59.5	205.7	133.8
Nephritis	51.5	74.1	99.8	109.2	99.0	78.5	166.4	141.6
Cancer	60.4	97.7	62.2	53.9	124.7	145.2	124.1	105.0
Diseases of the nervous system	46.4	88.0	77.3	97.4	71.5	89.0	120.0	127.2
Tuberculosis	25.5	34.0	66.4	93.7	46.9	38.5	141.6	116.5
Accidents other than motor vehicle	36.3	46.0	48.4	51.6	43.9	47.2	66.0	55.4
Premature birth	24.5	23.2	42.1	32.0	31.7	23.0	105.4	43.5
Syphilis	4.6	8.8	48.6	45.6	15.5	10.7	89.5	63.7
Motor vehicle accidents	22.6	26.4	14.9	12.1	31.7	26.6	23.5	26.5
Diarrhea, enteritis, etc.†	10.7	8.4	23.3	19.7	10.5	5.4	20.9	12.2
Diabetes	12.2	20.5	12.1	11.1	28.1	32.8	18.7	25.3
Homicide	4.6	3.3	14.9	231	6.0	3.1	38.1	44.4
Puerperal Causes	7.0	6.0	19.5	18.6	7.2	5.3	19.0	14.9
Hernia	6.7	7.6	9.5	8.2	11.4	9.6	16.8	14.0
Appendicitis	7.3	8.5	7.3	7.5	13.4	10.8	13.0	13.5
Cirrhosis of the liver	5.8	5.5	3.9	3.6	15.3	11.4	12.1	8.2
Congenital malformations	8.1	10.2	7.6	5.5	10.7	10.5	7.9	6.8
Suicide	8.3	13.3	1.3	3.0	18.2	17.1	2.8	6.4
Whooping cough	2.9	2.5	15.6	7.5	3.3	1.2	6.0	4.1
Ulcer of the stomach	5.3	5.2	4.9	4.0	7.2	8.0	6.7	9.0
Malaria	3.3	1.0	7.8	8.5	.9	.3	3.5	2.4
Typhoid and paratyphoid fever	1.6	1.2	6.9	3.9	1.8	.6	5.7	2.4
Pellagra	1.1	1.7	7.8	7.8	1.0	.6	5.1	4.7
Diphtheria	2.0	1.5	3.2	2.3	1.6	.7	1.3	1.2
All causes	706.5	949.6	1139.7	1218.6	1171.2	1109.4	1792.8	1561.0

*Based on populations enumerated as of April 1, 1940.

†Under two years only.

But, on the other hand, white and colored residents of the rural districts of the state were not as apt to succumb, proportionately, to the disease as were rural dwellers of the country as a whole in 1940. Death rates from syphilis in the state were higher than the national average for all groups except the rural whites. Malaria, too, proved more likely to be fatal in Louisiana than in the United States among all racial and residential groups except the rural Negroes, for whom the death rate in the state was close to that in the nation.

As would be expected on the basis of Louisiana's heavy loss of life among infants, causes associated with premature birth are responsible for a higher proportion of deaths in the state among all racial and residential groups than in the nation. However, this is largely due to the high proportion of Negroes in Louisiana. Congenital malformations are only slightly more likely to be fatal to colored Louisianians than to the colored in the nation as a whole, while among whites they seem a little less prevalent in the state than in the United States. Puerperal causes are responsible for higher proportions of deaths in all population groups in Louisiana than in those in the nation.

Fortunately the transmissible diseases and those associated with childbirth and infancy are the ones most susceptible to control. They are not nearly so baffling as the degenerative ailments. Therefore, with the perfection of health and sanitary services, a general rise in the educational level, and more widespread diffusion of sanitary, nutritional and nursing information, the state may be expected to reduce the mortality rate from most of these causes to a considerable degree. Particularly important is the improvement of the situation among Negroes, so that they will serve less as the carriers of disease germs, deadly killers which attack all people irrespective of race.

The chief deficiency ailment, pellagra, seems to afflict Louisianians slightly more than it does people generally in the United States. Fatalities from this cause are higher, proportionately, among the urban residents of the state, both white and colored, than in the nation; however, in rural areas, Louisiana's colored residents are about as likely to die from this cause as those in the nation, and her whites are somewhat less likely to have pellagra given as the cause of their deaths.

The citizen of Louisiana is slightly less likely to have his life snuffed out in a violent manner than the average person in the United States. This is chiefly because the suicide rate in Louisiana is so much lower than the national average, for accidents do not take an unusually low toll of life in Louisiana and homicide is much more prevalent in the state than in the nation. The low incidence of suicide, in turn, is due to the large proportion of Negroes in the state, for, as indicated above, very few Negroes take their own lives. However, Louisiana Negroes, both urban and rural, are less likely to commit suicide than their fellows elsewhere in the nation; and Louisiana rural whites also are much less prone to take their own lives than are rural whites in the nation as a whole. The high frequency of homicide in the state, on the other hand, likewise can be partially explained in terms of relative importance of the Negro population, among whom homicide rates are generally high. However, the comparisons should be made with residential groups subdivided according to race, when it apears that Louisiana Negroes are less prone to homicidal tendencies than the average in the nation, while Louisiana's white people are more likely to die at the hand of another than is true generally in the United States.

Contrasted with its poor showing in comparison with the nation in the control of transmissible diseases is the state's record with respect to the degenerative ailments. Most of these, the more baffling problems from the health standpoint, which are responsible for such a large share of the total number of deaths which occur annually in Louisiana, account for an even higher proportion of the annual death toll in the nation. Thus in Louisiana heart disease kills about 256 persons annually per 100,000 of the population, but the comparable rate in the country as a whole is 292. In other words, proportionate to the population, for every 100 deaths in the nation from this disease in 1940 there were only 88 in Louisiana. Relative to population, diabetes claims 66 lives in the state for each 100 in the nation; ulcer of the stomach, 90; and cancer and diseases of the nervous system between 70 and 80. Nephritis, on the other hand, seems slightly more likely to be fatal to Louisianians, and appendicitis kills about the same proportions of the residents of the state and the nation.

Greater resistance to the degenerative diseases in the state is confined mostly to the white population; and it is the rural whites of the state who make the best showing of all in this respect. In 1940 white people in rural Louisiana enjoyed lower rates of mortality than did rural whites of the nation from all of these diseases associated with advancing age except ulcer of the stomach, for which rates in the state and nation were equal. Urban whites of the state, too, make a fairly good showing in comparison with the urban whites of the nation in resisting disesaes of this type. However, the death rates from heart disease among whites in the towns and cities of Louisiana were about equal to those in the nation, and nephritis and appendicitis were a little more prominent as causes of death among white people in urban Louisiana than in urban parts of the United States as a whole. But neither Louisiana nor the United States seems to enjoy much advantage over the other with respect to deaths from the degenerative diseases among the colored populations. Negroes in rural districts of Louisiana died somewhat less frequently, proportionately, than did the rural colored of the nation in 1940 from nephritis and diseases of the nervous system and to about the same extent from disabetes; but, on the other hand, diseases of the heart, cancer, and ulcer of the stomach were somewhat more likely to be fatal to Louisiana's rural colored people. Urban colored in Louisiana were characterized by higher rates of death in 1940 from heart disease, cancer, and nephritis; by lower rates from diseases of the nervous system, diabetes, and ulcer of the stomach. Appendicitis proved about as dangerous to colored people in the state as to those in the nation generally.

IV. HEALTH IS IMPROVING

That the health of Louisiana's population is improving, and rapidly, there can be no reasonable doubt. Less satisfactory are the conclusions with respect to trends in the state in comparison with those in the nation. The close associations between race and mortality and residence and mortality, demonstrated in preceding sections, indicate that both race and residence must be taken into account before additional analysis can be of much value. But the data for the past are not tabulated in a manner that makes it possible to make the necessary refinements in the analysis of trends. For example, it is probably absolutely impossible to trace the mortality from tuberculosis or diseases of the heart for rural (either in centers under 2,500 or under 10,000 population) whites or rural Negroes in the United States over the period from 1920 to 1940. Only in 1939 and 1940 did the Bureau of the Census begin tabulating deaths in detail by place of residence. The earlier tabulations were by place of occurrence. This distinction is all important in any analyses in which the residential factor, the difference between rural and urban areas, enters. Not only are we unable to compare the trends in city and country, but inability to adjust for the residential factor makes us less certain of the racial differences in the trends and in the comparative trends in Louisiana and the nation than we should like to be.

A. Control of the Common Causes of Death Since 1920

As late as 1920 pneumonia and influenza, and tuberculosis were the most deadly diseases in Louisiana. Typhoid fever and malaria still ranked among the first ten causes of death at that time, and

TABLE V

Mortality Rates from the Common Causes of Death in Louisiana, 1920 and 1940, by Race*

Cause of death	Rates per 100,000 population					
	Total		White		Colored	
	1940	1920	1940	1920	1940	1920
Diseases of the heart	256.6	119.6	240.5	103.4	285.2	144.8
Pneumonia and influenza	107.2	158.2	79.3	137.8	156.7	190.1
Nephritis	91.8	86.6	73.0	75.4	125.1	104.0
Cancer	87.7	49.0	89.0	52.3	85.3	43.8
Diseases of the nervous system	70.6	53.1	57.7	49.9	93.4	58.1
Tuberculosis	58.8	140.6	38.4	80.9	95.2	233.7
Accidents other than motor vehicle	44.8	59.6	40.9	53.7	51.6	68.9
Premature birth	37.1	27.1	27.7	27.6	53.7	26.3
Syphilis	29.2	24.4	9.8	14.1	63.7	40.4
Motor vehicle accidents	24.2	5.0	27.8	6.4	17.6	2.7
Diarrhea, enteritis, etc.	17.6	51.7	13.0	46.0	25.9	60.7
Diabetes	17.5	7.8	19.2	9.5	14.4	5.1
Homicide	12.0	14.0	5.5	6.9	23.6	25.1
Puerperal Causes	11.5	24.4	7.1	19.9	19.4	31.5
Hernia	10.1	10.0	9.0	8.7	12.1	12.1
Appendicitis	9.7	12.9	9.9	13.5	9.3	12.0
Cirrhosis of the liver	9.0	8.8	10.1	9.1	6.9	8.3
Congenital malformations	8.8	12.6	9.5	11.8	7.7	13.8
Suicide	8.5	4.7	12.4	7.2	1.8	.8
Whooping cough	6.3	10.1	3.1	8.4	12.1	12.8
Ulcer of the stomach	6.1	3.7	6.4	3.6	5.6	4.0
Malaria	3.7	32.3	2.3	28.4	6.2	38.4
Typhoid and paratyphoid fever	3.4	15.4	1.7	11.7	6.5	21.3
Pellagra	3.2	11.2	1.1	4.3	6.8	22.0
Diphtheria	2.1	6.1	1.9	6.7	2.5	5.2
All causes	1085.0	1188.5	917.8	977.9	1381.6	1517.0

*Rates published in *Vital Statistics Rates in the United States,* 1900-1940.

diphtheria was responsible for many times the number of lives it now takes. During the 20 years, to 1940, the people of Louisiana made noteworthy progress in bringing these and other transmissible diseases under control.

Since 1920 the annual number of victims to pneumonia and influenza has been substantially reduced, although the rates still fluctuate greatly from year to year. In 1940 the rate was 50 per 100,000 below that in 1920. (See Table V and Figure 4.) This has meant a great saving in lives. The new types of chemotherapy which are now being successfuly used in the treatment of these diseases will undoubtedly serve to lessen the severity of future epidemics and diminish the rates still further in the future. However, the general level of deaths still remains high, as evidenced by the fact that pneumonia and influenza ranked second in numerical importance among all causes of death in the state in 1940. Efforts to control them should be strengthened, not relaxed.

Progress made in the state in reducing the fatality of tuberculosis has been little short of spectacular. The death toll from the disease has been cut by more than one half over the past two decades, and on an annual basis it now kills only about 59 persons out of each 100,000 in the state as compared with 141 in 1920. To save the 82 lives per 100,000 population, lives that would have been lost under the conditions prevailing in 1920, in an outstanding accomplishment in preventing wastage of human resources.

Great strides also have been made in bringing under control deaths from diarrhea and enteritis. These diseases occupied a much higher position among the causes of death in 1920, when they killed about 52 persons per 100,000, than in 1940 when the rate was 18 per 100,000, or only about one third of the former figure.

Typhoid fever is less than one fourth as important at the present time as it was when Louisiana entered the Registration Area, and mortality from malaria only about one eighth of what it was in 1920. Annually about 12 fewer persons in each 100,000 in the state are dying from typhoid than was the case two decades ago, and almost 30 less from malaria. Rates of death from diphtheria and from whooping cough have shown substantial improvement. In fact, for many of the common transmissible diseases, including tuberculosis, typhoid fever, diphtheria, and malaria, the 1940 rates of death were the lowest ever recorded. On the other hand, the mortality rate from syphilis is the only one which failed to show marked improvement.

The state has likewise been fairly successful in reducing the death toll from conditions associated with maternity and has curbed homicide to some extent. New minimal rates were also established for these two causes in 1940. The annual death toll from pellagra, a disease closely related to adequacy of diet, is now, like those of the some of the infectious diseases, only a fraction of what it was in 1920. For this disease, too, a new low mark was reached in 1940. The death rate from accidents other than those in which motor vehicles were involved has been materially reduced, by about 15 deaths per 100,000 of the population, but accidents are still responsible for a sufficiently large number of deaths to make them rank among the ten leading causes of death. Notable advances have been made in reducing the death toll from appendicitis, and the rate from this cause in 1940 is lower than that for any previous year.

With respect to the control of other causes of death the state has not been so successful, and some of them have increased materially in importance since 1920. This has been especially true of the degenerative ailments, which remain the great unsolved health problems as increasing proportions of people reach the advanced ages. Deaths from heart disease have mounted steadily until by 1940 the loss of life was twice as great as it was in 1920. Two decades ago about 120 persons in the state out of each 100,000 died of heart disease; the rate in 1940 was 257, the highest on record. Cancer is likewise claiming a higher toll of lives today, the rate of 49 deaths per 100,000 in 1920 having increased to about 88 in 1940, or an increase of 39 deaths per 100,000 of the population. Diseases of the nervous system kill somewhat more persons at the present time (about 17 per 100,000 more) than they did 20 years ago, and the fatality of diabetes and ulcer of the stomach have both increased substantially. The 1940 rate of 17.4 deaths from diabetes per 100,000 of the population was the highest ever recorded for the disease. Although nephrtis has not increased in importance to the same extent as have other diseases of a degenerative nature, its annual death toll has not been significantly reduced. About the same proportion of persons (91.8 per 100,000) are dying of the disease today as in 1920 (86.6). To a limited extent these increases in the death toll attributed to degenerative ailments are a reflection of better diagnosis, and the reduction in the proportion of deaths classified as due to ill-defined or unknown causes. Nevertheless, there can be no doubt that the degenerative ailments have increased sharply, and that they probably will continue to gain in importance.

Motor vehicle accidents, particularly, and suicide to a lesser extent are also proving more important as causes of death than they were two decades ago. The death rate of 24.1 for motor vehicle accidents in 1940 was higher than that of any other year except 1936, when there slightly more, or 25.7 fatalities per 100,000 of the population from this cause. .It was between four and five times as great as the rate of 5.3 which prevailed 20 years ago. The variation in suicide rates is not nearly so wide, although the 1940 rate of 8.5 is somewhat above the median annual rate for the 20-year period over which comparisons were made.

B. Trends by Race.

In absolute gains in lives saved over the past two decades, Louisiana's colored people seem to have shared to a somewhat greater extent than have her whites, proportionate to their numbers in the population. This is due primarily to the great strides which have been made in controlling certain of the transmissible diseases among Negroes. The most outstanding example of this is in the case of tuberculosis. Colored people were dying in 1920 at the rate of about 234 per 100,000 from tuberculosis, while in 1940 the rate had been cut to 95, or by 138 deaths per 100,000 of the population. The whites, for whom the rate was much lower at the beginning of the period, or 80.9, reduced theirs to the rather favorable figure of 38.4, or by 42.5 deaths per 100,000 of the population. (See Table V.) Larger absolute reductions were characteristic of Negro than of white death rates for malarial and typhoid fevers and for diarrhea, with the result that the rates of mortality for all these causes for the two races approximated each other more closely in 1940 than in 1920. In addition, Negroes of the state registered a much larger absolute reduction in deaths from pellagra than did whites, and they seem to have improved their situation a little more with respect to fatal accidents other than those involving motor vehicles. And accidents with motor vehicles which were, in 1940, killing about 20 more whites of each 100,000 than they were in 1920, had increased by only about 15 per 100,000 among colored.

On the other hand, with respect to gains made in the control of other of the causes of death, advances made by whites over the 20-year period were more outstanding than those made by Negroes. The fatality of pneumonia and influenza seems to be yielding somewhat more rapidly among the former, and the measures adopted by whites in curbing deaths from diphtheria and whooping cough are apparently proving a little more effective. Whites have also registered a little success in the control of deaths from syphilis, a cause which seems to have increased in importance in the Negro population. Rather substantial improvement (amounting to a reduction of 12 deaths per 100,000 population) in conditions associated with maternity has been characteristic of both races.

The degenerative diseases as a whole seem to have advanced a little more rapidly in importance as causes of death among colored people. Diseases of the heart are killing about 137 more white persons today out of each 100,000 than they were in 1920; they are responsible for 141 more colored deaths per 100,000 population than they were two decades ago. On an annual basis per 100,000 population, cancer is now killing 37 more whites, and 41 more Negroes, respectively; and deaths from disease of the nervous system, which have increased only by about 8 per 100,000 among whites, have increased by 25 among nonwhites. Deaths from nephritis, which show a slight tendency to decline among whites since 1920, have increased by about 20 per 100,000 among nonwhites. These differences may be accounted for in part by more accurate assignment of deaths by cause at the present time among the state's Negroes,[7] and in part by the fact that as mortality from the transmissible diseases is reduced among them, a larger share of this race lives to reach the advanced ages.

C. Comparative Trends in Louisiana and the United States.

In final analysis the improvement in the health of Louisiana's population is to be judged in relation to comparable changes in the nation. This section analyzes the extent to which the state has kept pace with the nation in the control of the more important causes of death.[8]

A careful study of the evidence demonstrates that during the last 20 years Louisiana has not kept pace with the nation in the control of transmissible diseases. Neither among the white population nor the colored population do the trends compare favorably with those for the same groups in the United States. Consider some of the evidence.

Tuberculosis. Tuberculosis is one of the infectious diseases in Louisiana's record compares most favorably with that of the nation. For the total population the rate of fatalities from this scourge was consistently higher in the state than in the nation over the period 1920-1940. (See Figure 3.) However, the fact of the higher rates in the state is due entirely to the presence of the large Negro population, for the death rate from tuberculosis among Louisiana Negroes is consistently below that for the Negroes of the nation, and Louisiana whites, too, generally have been decimated less rapidly by tuberculosis than those in the United States as a whole. This illustrates a point that should be uppermost in all of the comparisons, namely, that judgments should be based on the extent to which the reduction in the mortality among Louisiana's white people keeps pace with that among white people elsewhere, and that among Louisiana's Negroes is in line with that of Negroes in other parts of the nation. With respect to Negroes, the trends are clear and encouraging. Louisiana Negroes fell prey to tuberculosis less frequently than their fellows elsewhere in 1920. During the period of rapid improvement to 1940, measures taken in the state were even more effective than those applied generally. Louisiana Negroes now enjoy an even greater margin of safety over those of the United States than they had in 1920. But among the white population the trends are not so flattering to the state's pride. In 1920 Louisiana's advantage over the remainder of the nation was pronounced. Since that time improvements have been made, but in other parts of the nation the control of mortality from tuberculosis has proved more effective. By 1940 the white people of Louisiana were falling prey to tuberculosis at a higher rate than those in the other parts of the nation.

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[7] In 1920 the death rate among colored for "senility" was 45.0 per 100,000; in 1940, it was 15.0. For whites in 1920 it was 16.6; in 1940, 7.2. For "ill-defined causes" the rates for colored were: 1920, 63.1; 1940, 23.1 for whites, 1920, 16.4; 1940, 6.4.

[8] For these purposes the nation is defined as the death registration area as it was constituted in 1920, when the following 35 states were included: California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, Ohio Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington and Wisconsin.

Pneumonia and Influenza. Mortality from these causes is very erratic. (See Figure 4.) As in the case of tuberculosis, white Louisianians have lost the superiority they once possessed over their fellows elsewhere. The same is probably true for the Negro population.

Typhoid and Paratyphoid. With respect to typhoid and paratyphoid, the state continues to make a pitiful showing. (See Figure 5.) Among both whites and Negroes, deaths from these unnecessary causes were much higher than those in the nation in the early 1920's. The improvements made by 1940, while substantial, still were not sufficient. Louisiana still occupies an unenviable position in the control of these diseases.

Diarrhea and Enteritis. On the whole the control of diarrhea and enteritis in Louisiana did not keep pace with that in the nation, and both whites and Negroes in the state compared more unfavorably with their fellows elsewhere in 1940 than they did in 1920. (See Figure 6.)

Malaria. Malaria has been of little importance, especially among whites, in the United States for many years. In Louisiana, however, it continues to take a considerable toll of life. (See Figure 7.)

Diphtheria. The white people of Louisiana, along with the Negroes, have now lost the superiority they once enjoyed over their fellows in other parts of the nation in the control of diphtheria. (See Figure 8.)

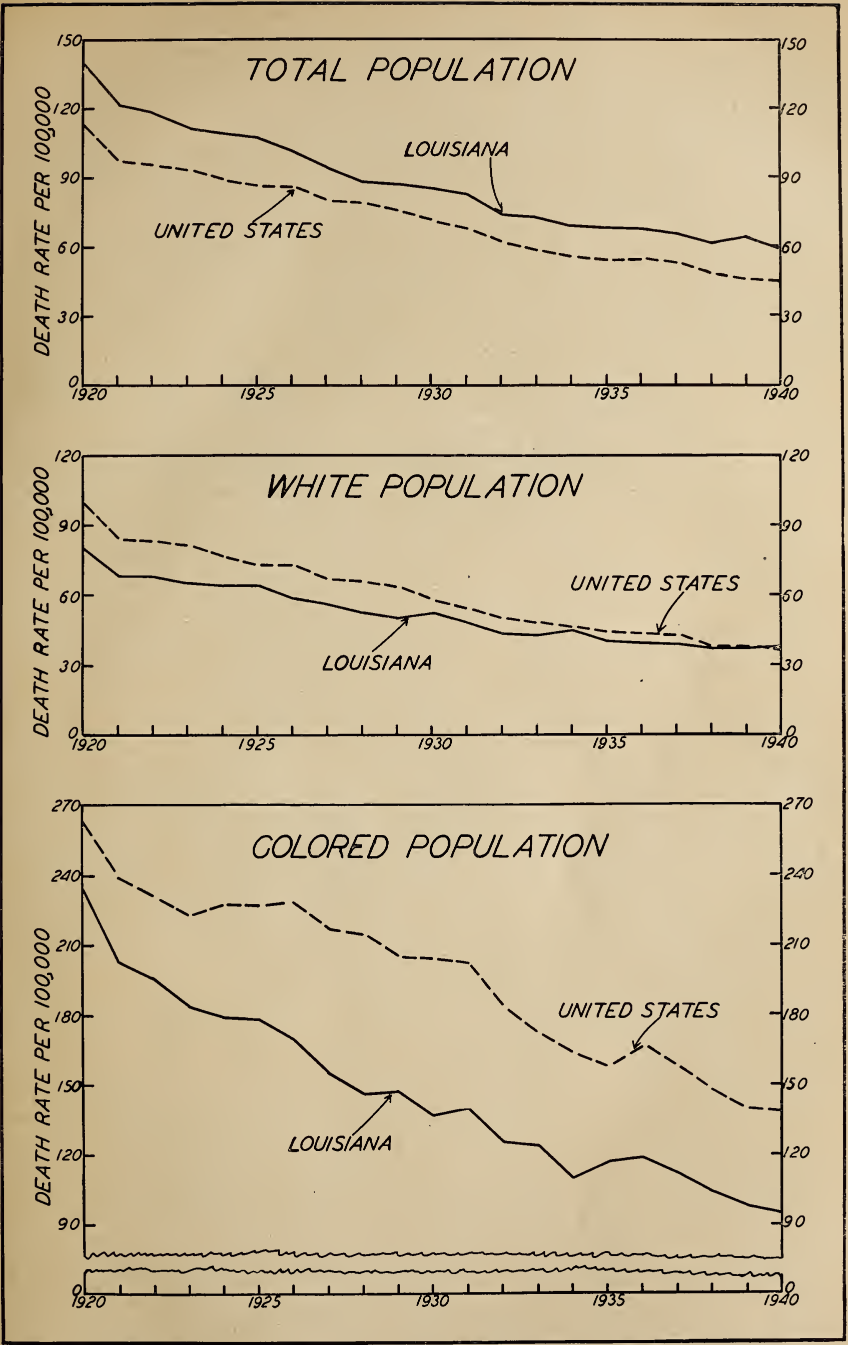

FIGURE 3. Annual Death Rates from Tuberculosis, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

Syphilis. Deaths attributed to syphilis continue to occur at about the same rate among the white populations of Louisiana and the nation. For Negroes the national rate seems to have overtaken that prevailing in the state. (See Figure 9.)

Whooping Cough. The death rates from whooping cough in Louisiana have not fallen with a speed comparable to that attained elsewhere. (See Figure 10.)

Allied to the transmissible diseases in that they are more readily controlled are the deficiency ailments. Pellagra is the chief one of these for which data are available. The state has now about overtaken the nation in the gradual elimination of this cause of death among white people, and it does not lag greatly in its control among Negroes. (See Figure 11.)

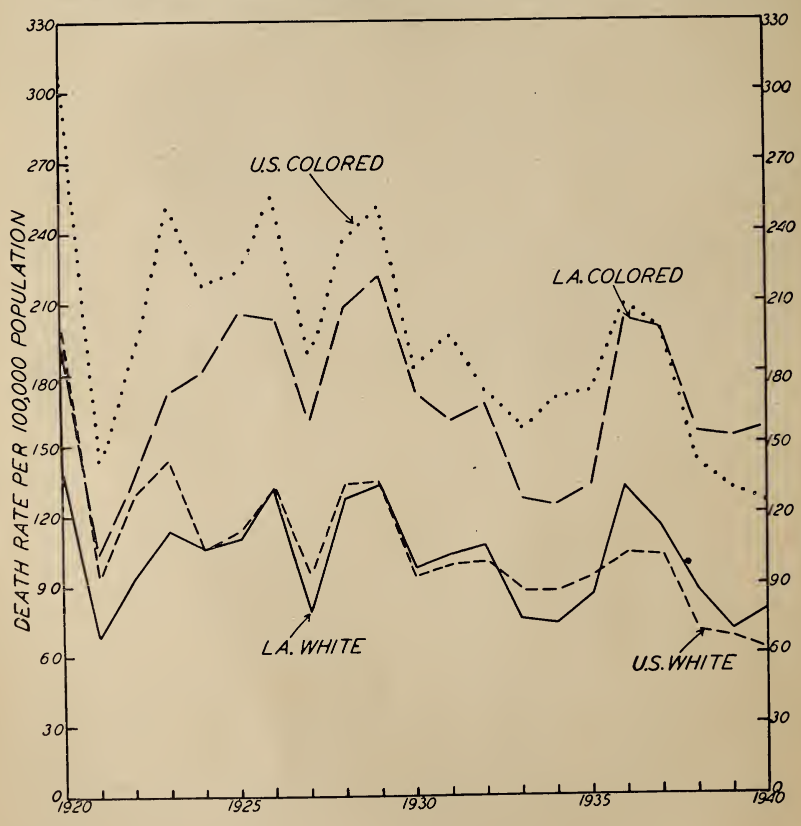

FIGURE 4. Annual Death Rates From Pneumonia and Influenza, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

Deaths associated with the bearing of children form another category that lends itself to control. Indicative of the lack of medical care is the fact that deaths from puerperal causes are not being eliminated as fully in Louisiana as elsewhere in the nation. (See Figure 12.) The state can hardly expect to come up to standard in this respect until the number and distribution of physicians are more adequate. As late as 1941, midwives attended 9.0 per cent of white and 55.3 per cent of the Negro live births, while in the nation as a whole the corresponding percentages were only 2.7 and 48.5.[9]

Fatalities attributed to premature birth are on the decrease in the nation. (See Figure 13.) The decrease among Louisiana white people is not so certain, and the Louisiana Negro population is characterized by a rising rate of mortality from this cause.

Most of the degenerative ailments, the causes of death which have pushed so rapidly to the fore in recent years, continue to take a rela-

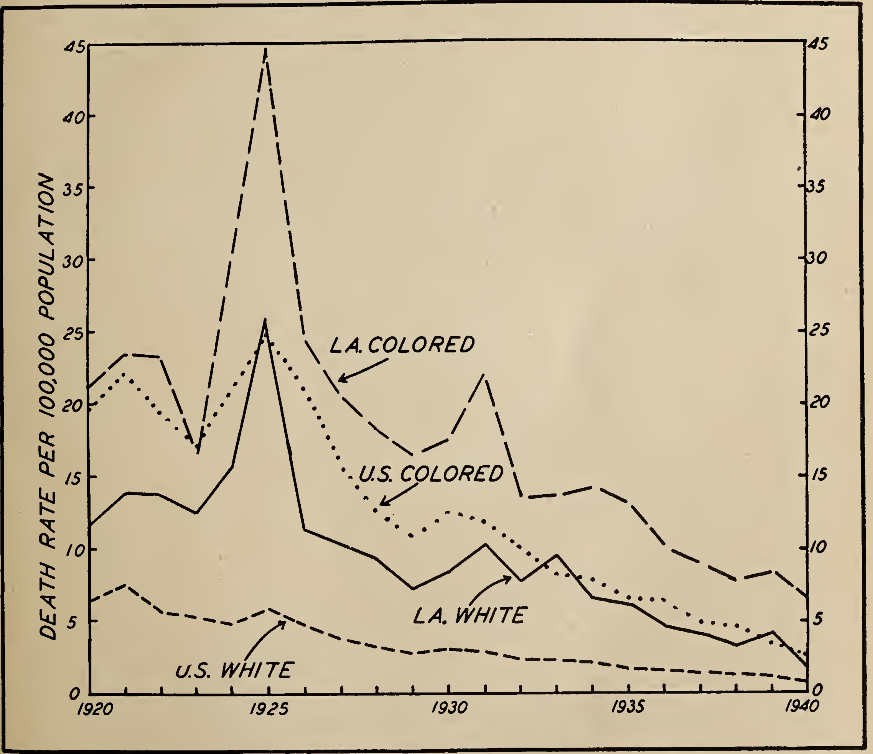

FIGURE 5. Annual Death Rates From Typhoid and Paratyphoid, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

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[9] Bureau of the Census, "Live Births by Person in Attendance: United States, 1941", *Vital Statistics — Special Reports,* Vol. 17, No. 4 (Dec. 10, 1942), pp 20-21.

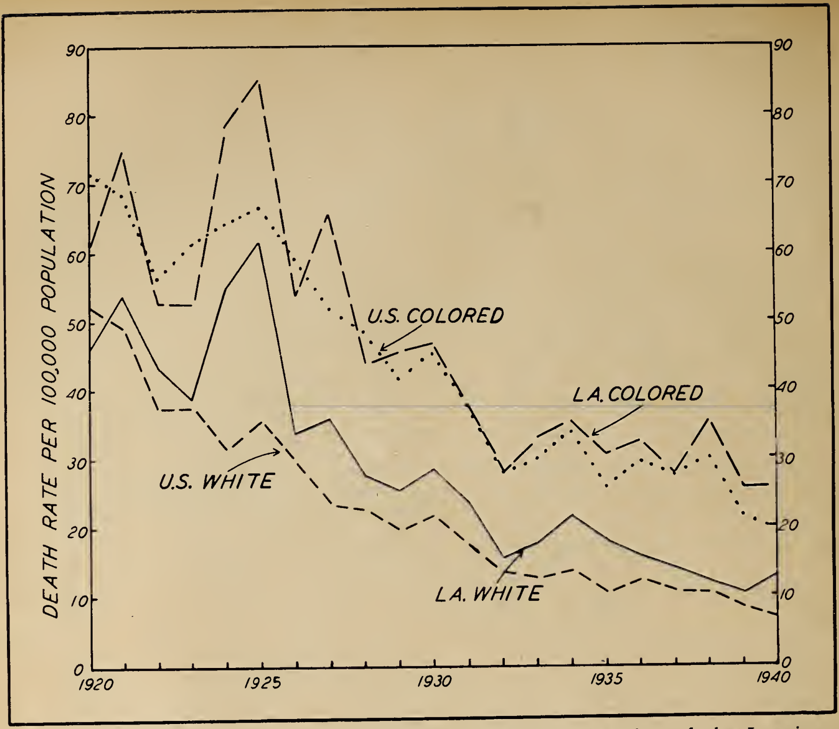

Figure. 6. Annual Death Rates From Diarrhea, Enteritis, Ulceration of the Intestines, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

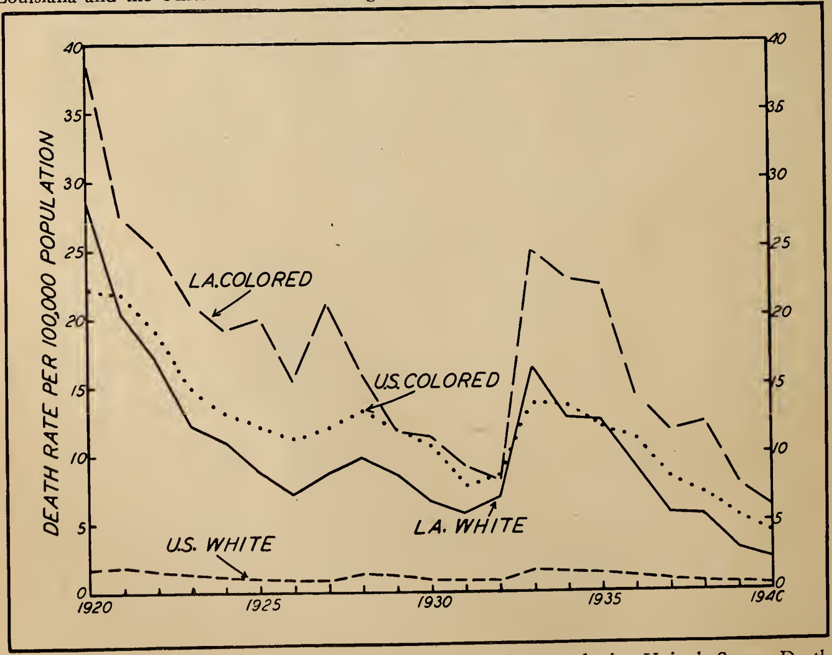

Figure 7. Annual Death Rates from Malaria, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

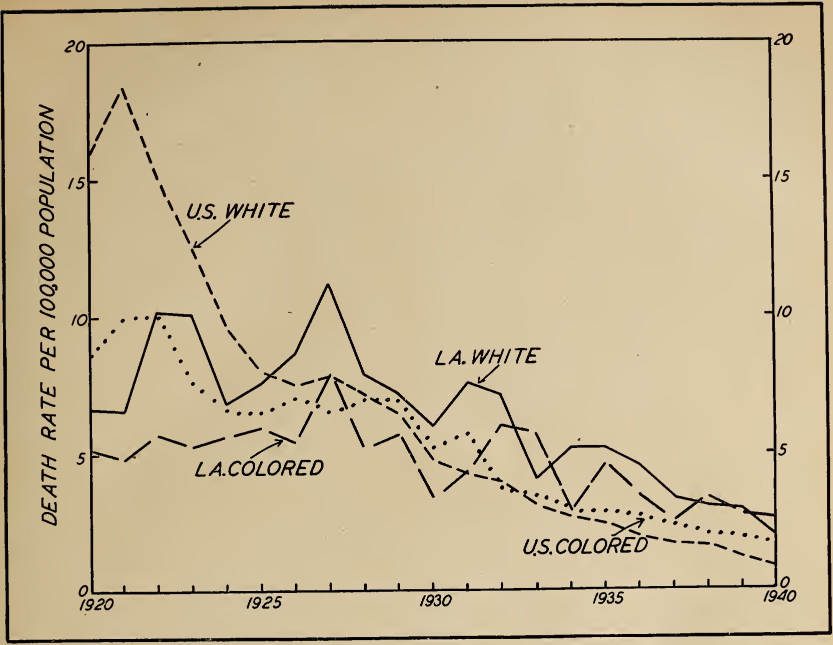

Figure 8. Annual Death Rates from Diphtheria, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

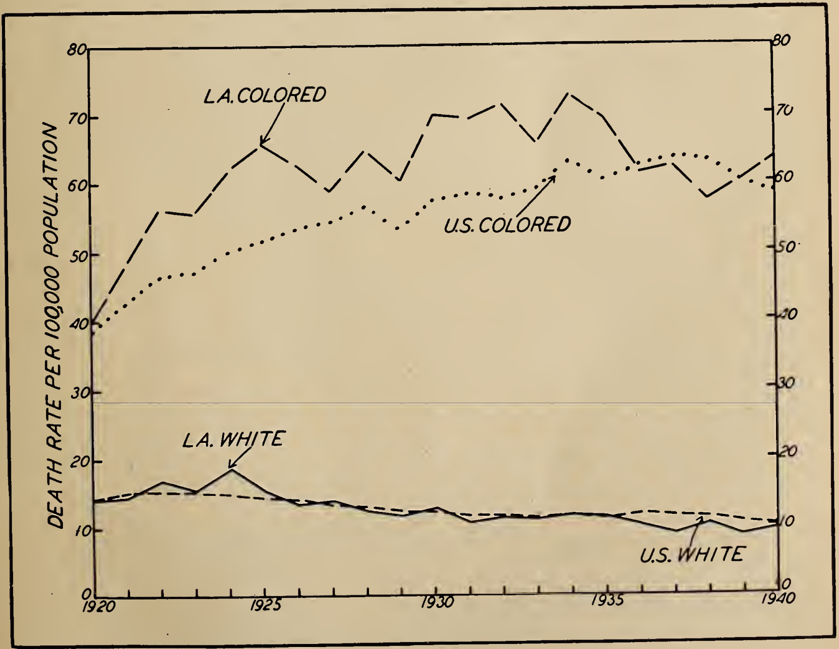

Figure 9. Annual Death Rates from Syphilis, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

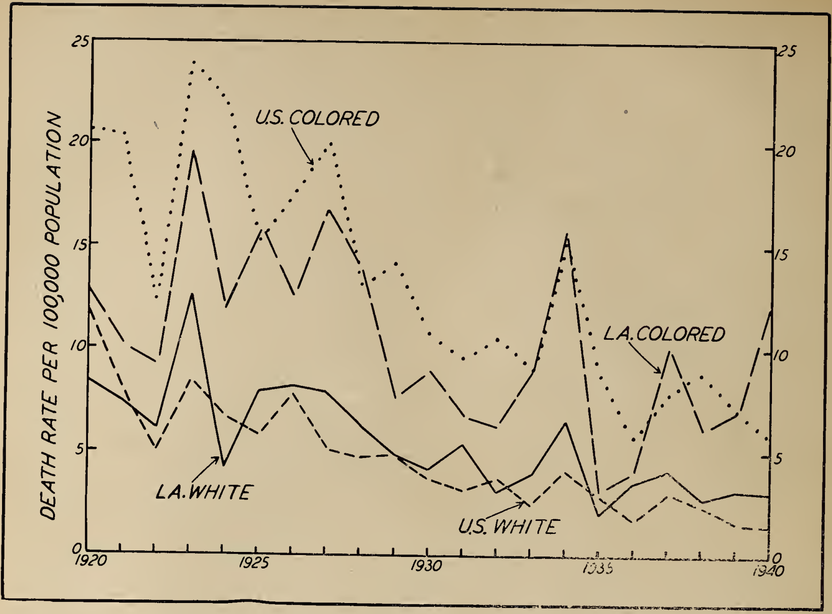

Figure 10. Annual Death Rates from Whooping Cough, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

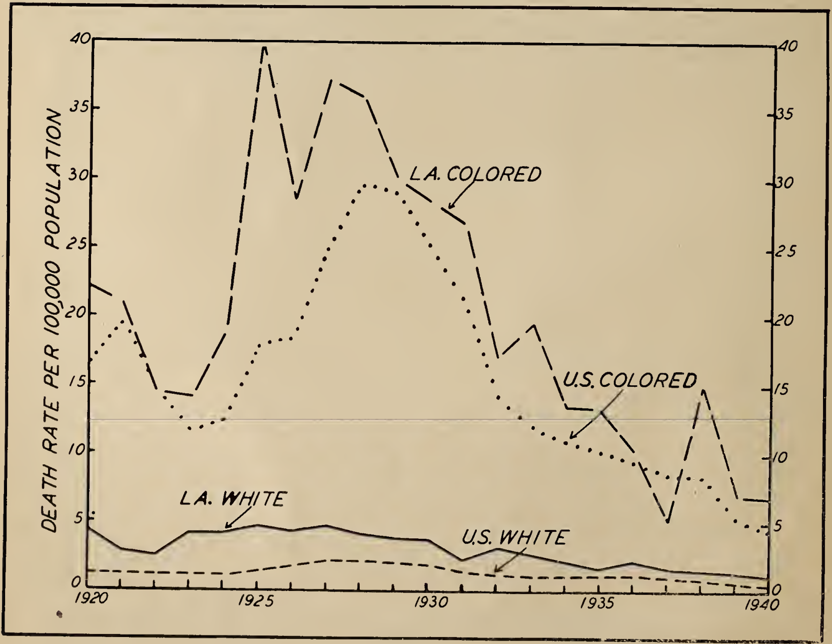

Figure 11. Annual Death Rates from Pellagra, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

tively smaller toll of life in Louisiana than in the nation. To a considerable degree this offsets the state's disadvantageous position in the control of the communicable diseases. Consider the comparative trends.

In 1940 heart diseases alone took the lives of twice as many persons out of every 100,000 white people as they did in 1920, but the increase in Louisiana hardly kept pace with that in the nation. (See Figure 14.) Among Negroes, however, the state compares somewhat unfavorably with the United States.

The death rate from cancer in Louisiana is mounting, but not so rapidly among white people as is the case elsewhere. (See Figure 15.) On the other hand, the rates for Louisiana Negroes have not diverged significantly from those prevailing in the nation.

Contrary to popular supposition, there has been no great rise in the fatalities due to diseases of the nervous system. (See Figure 16.) The rates in Louisiana are far below those for the United States, but the relative positions changed little between 1920 and 1940.

Nephritis takes a considerable toll of life, but it is not on the increase. (See Figure 17.) Louisiana rates are about the same as those prevailing in the United States generally.

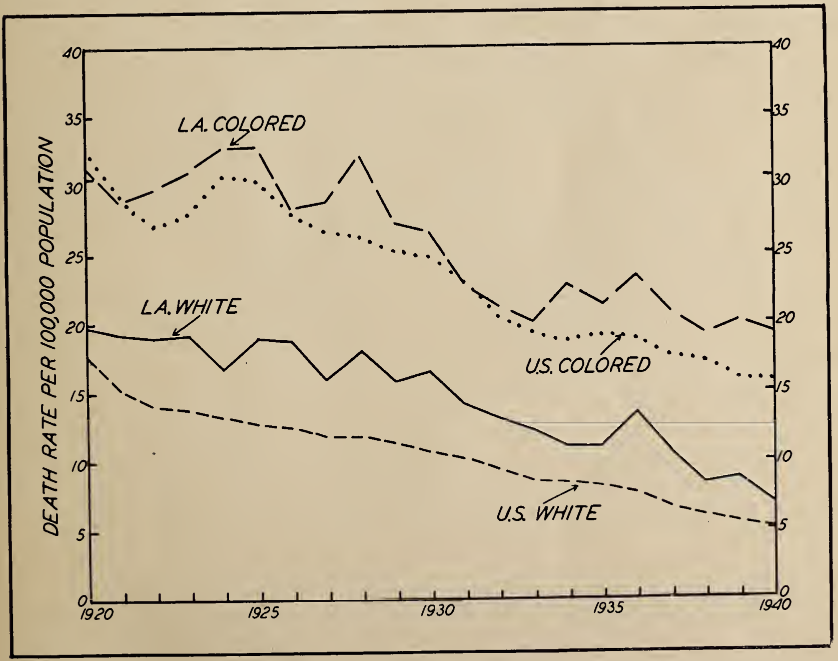

FIGURE 12. Annual Death Rates from Puerperal Causes, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

Ulcers of the stomach are increasing somewhat as a reported cause of death, but the rates in Louisiana continue to be somewhat below those in the nation. (See Figure 18.)

Diabetes is increasing rapidly as a reported cause of death in Louisiana as in the United States. (See Figure 19.) However, the rates in the state are mounting a little less rapidly than those in the nation. As a result Louisiana's advantage, already considerable in 1920, became more marked in the following 20 years.

The falling mortality rates from appendicitis will surprise most laymen. (See Figure 20.) The rates for Louisiana are slightly more erratic than those for the United States, but their magnitudes and trends are closely similar.

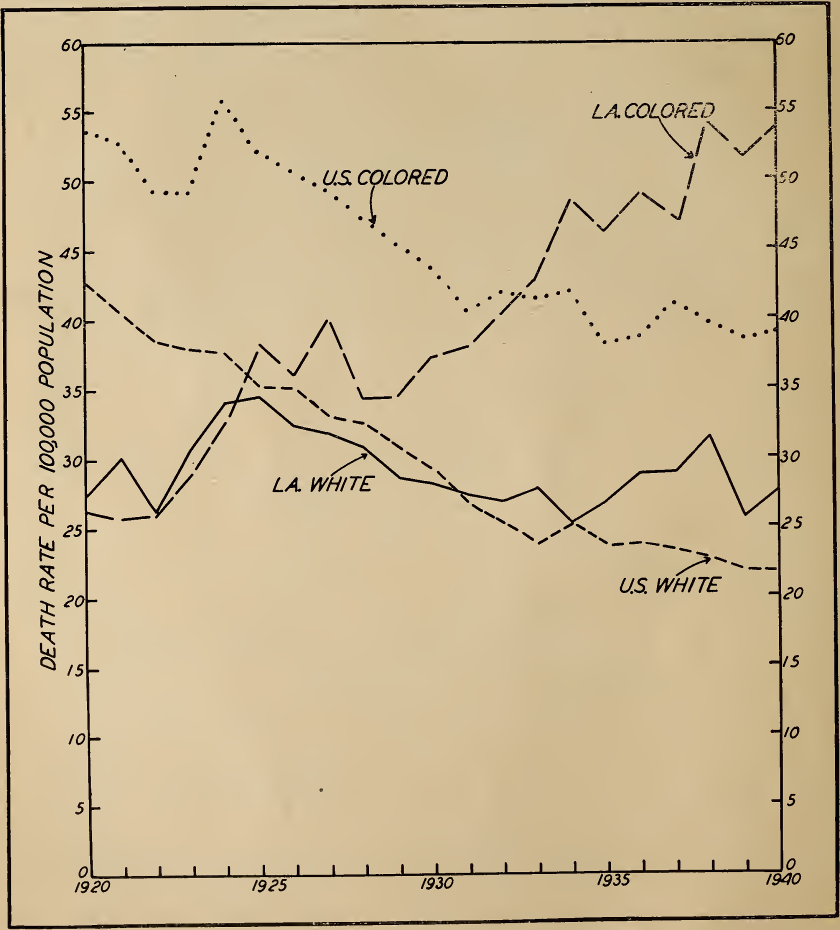

Figure 13. Annual Death Rates from Causes Associated with Premature Birth, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

Cirrhosis of the liver, hernia and intestinal obstructions take about the same tolls as in 1920. They are not particularly important, and Louisiana does not diverge significantly from the nation in mortality from these causes.

Congenital malformations are decreasing in importance as a reported cause of death. (See Figure 21.) The rates for Louisiana whites compare favorably, those for Louisiana Negroes unfavorably, with those for the United States.

Finally, there remain for consideration the trends in mortality from violence, accidents, and other external causes. Motor vehicle accidents, of course, increased spectacularly between 1920 and 1940. (See Figure22.) The rates in Louisiana lagged somewhat behind those of the nation; but among white people the differential has been elim-

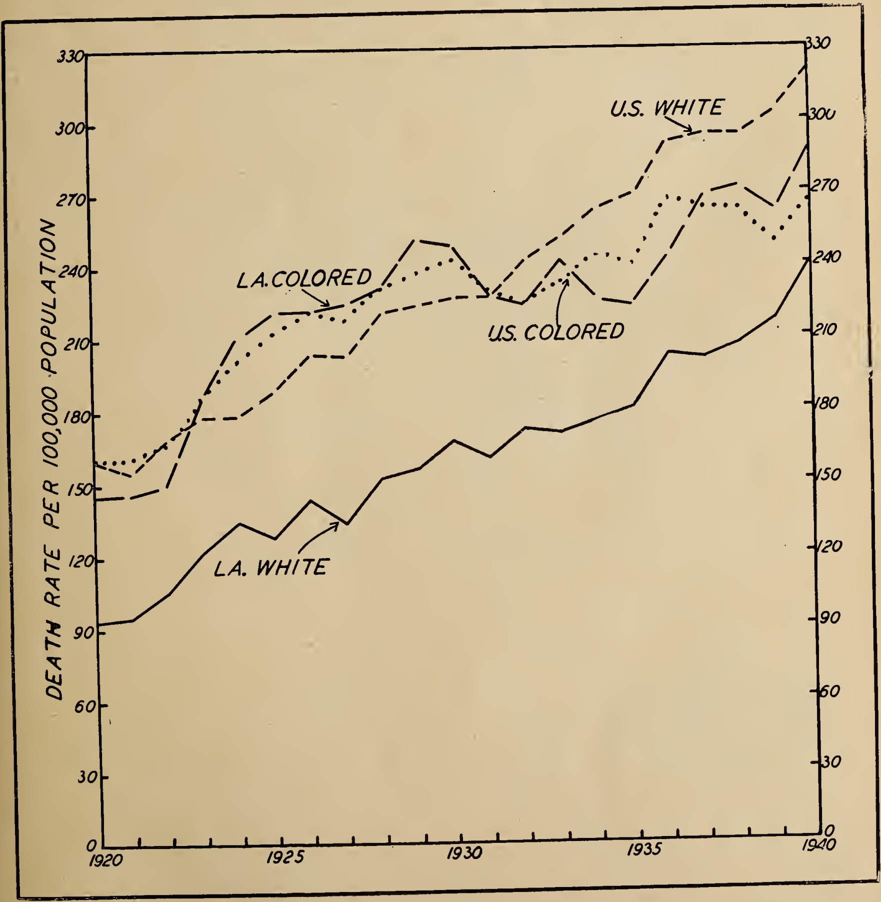

FIGURE 14. Annual Death Rates from Diseases of the Heart, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

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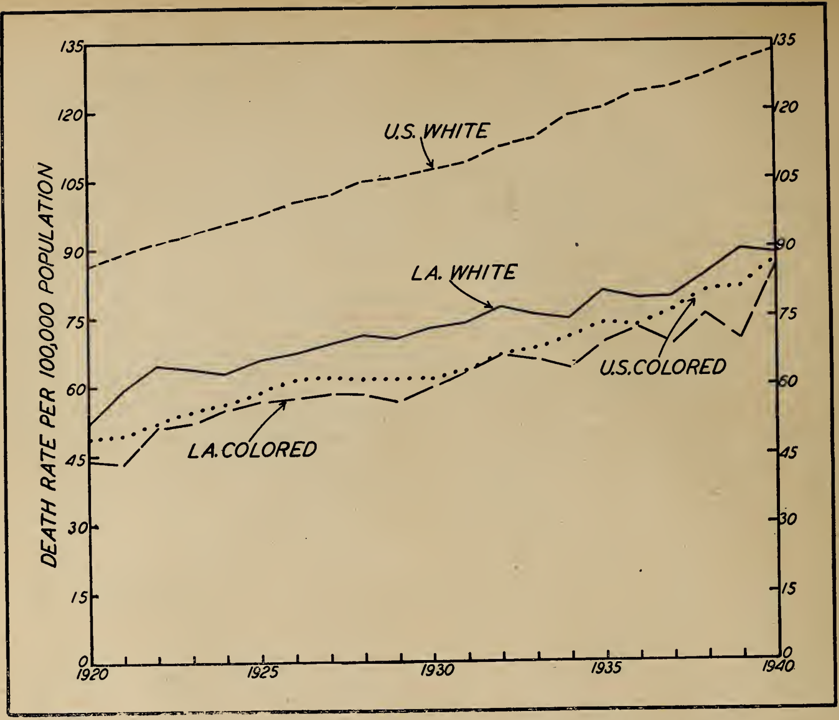

FIGURE 15. Annual Death Rates from Cancer, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

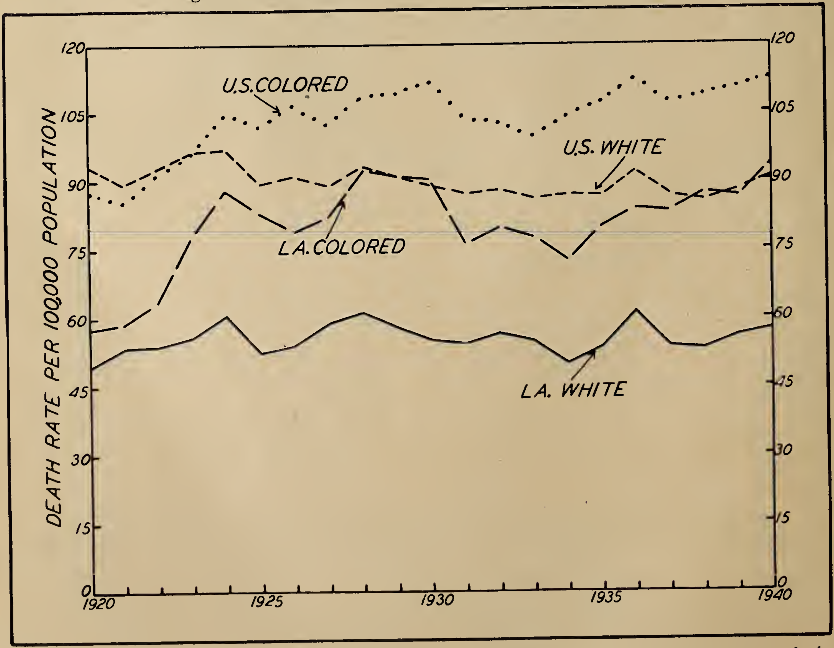

FIGURE 16. Annual Death Rates from Diseases of the Nervous System, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

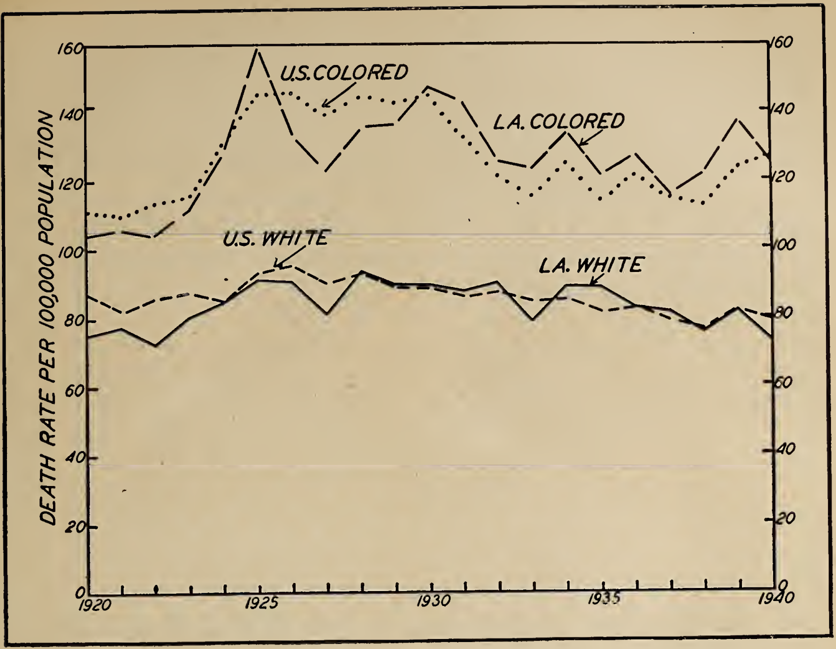

FIGURE 17. Annual Death Rates from Nephritis, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

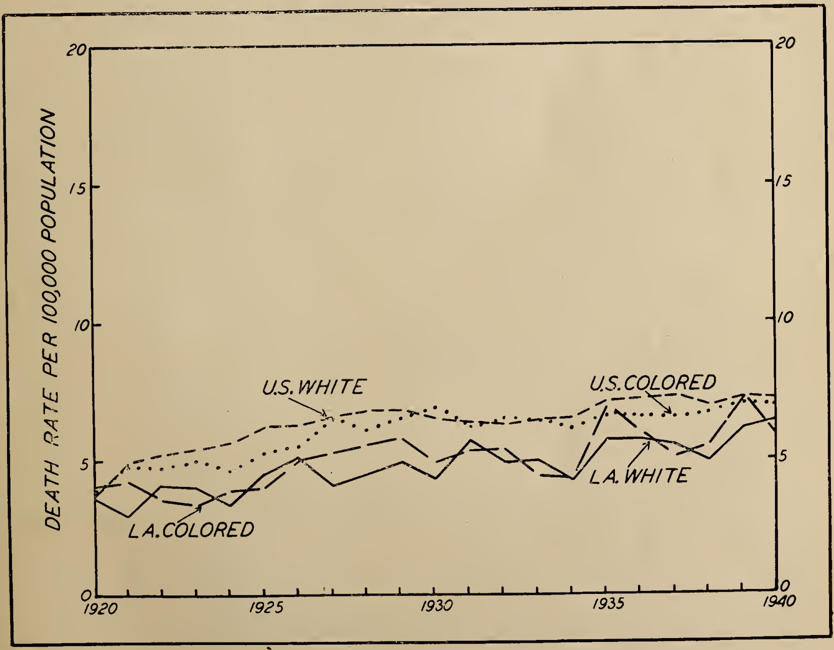

FIGURE 18. Annual Death Rates from Ulcer of the Stomach, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

inated by 1940. From other accidents, mortality has been slowly decreasing, perhaps a trifle more rapidly in Louisiana than in the nation generally. (See Figure 23.) The direct action of rural life is reflected in the high homicide rates among Louisiana's white population. Among Negroes the very high rates still do not equal those for the nation. (See Figure 24.) There may have been a slight improvement between 1920 and 1940. Low suicide rates are the counterpart of high homicide rates. Suicide rates increased slightly between 1920 and 1940, but the rates in Louisiana hardly kept pace with those for the nation. (See Figure 25.)

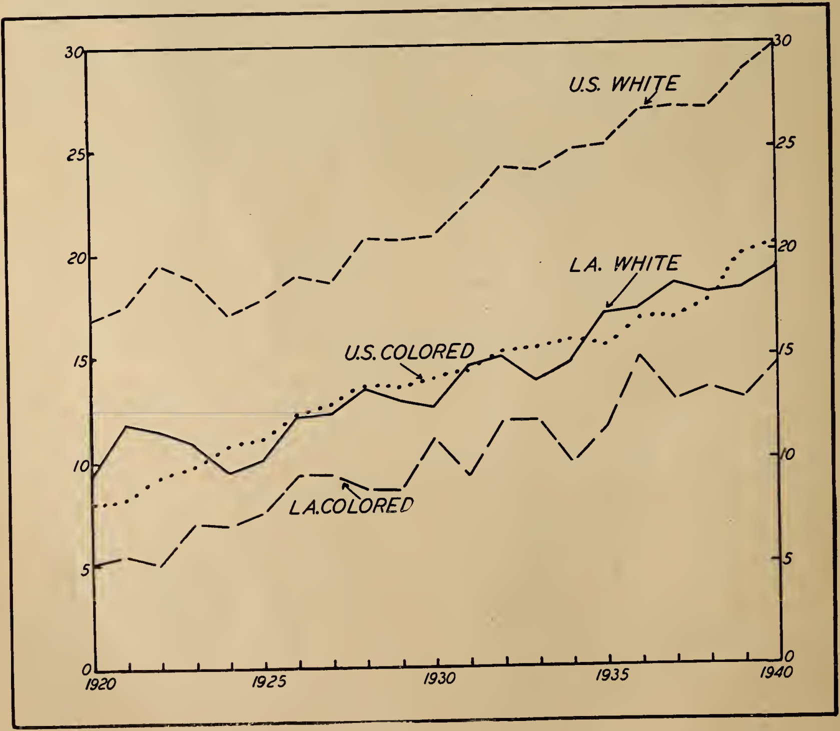

Figure 19. Annual Death Rates from Diabetes Mellitus, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

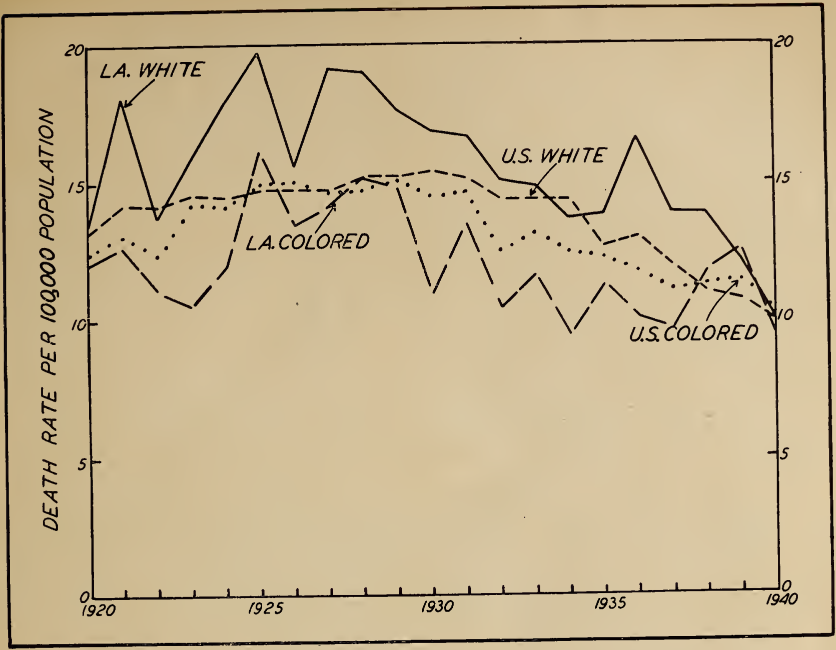

Figure 20. Annual Death Rates from Appendicitis, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

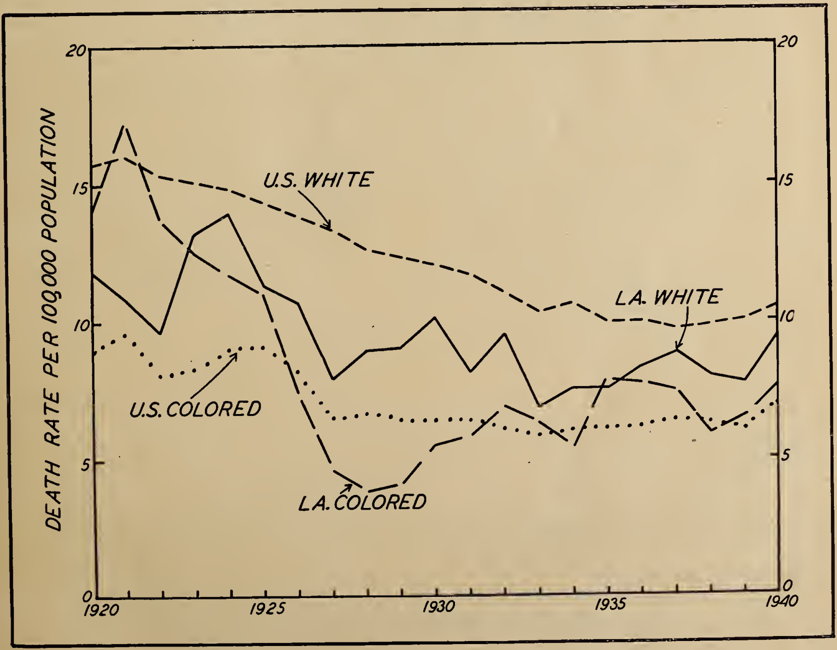

Figure 21. Annual Death Rates from Congenital Malformations, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

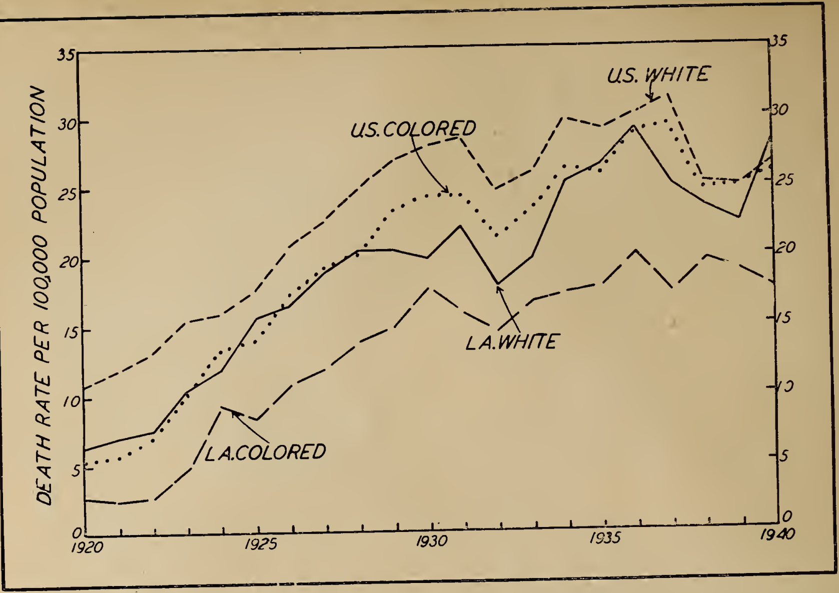

Figure 22. Annual Death Rates From Motor-vehicle Accidents, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

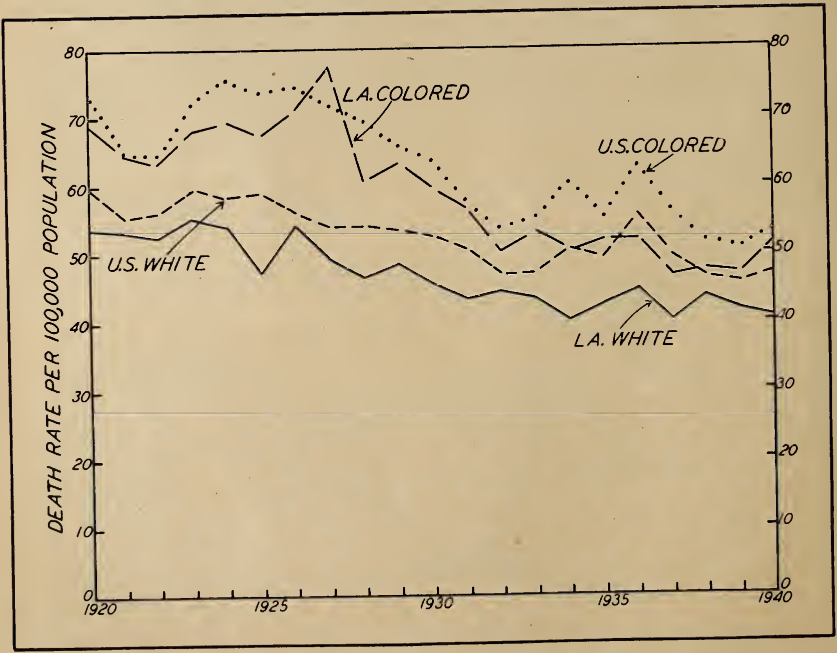

Figure 23. Annual Death Rates from Accidents Other than Motor-vehicle, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

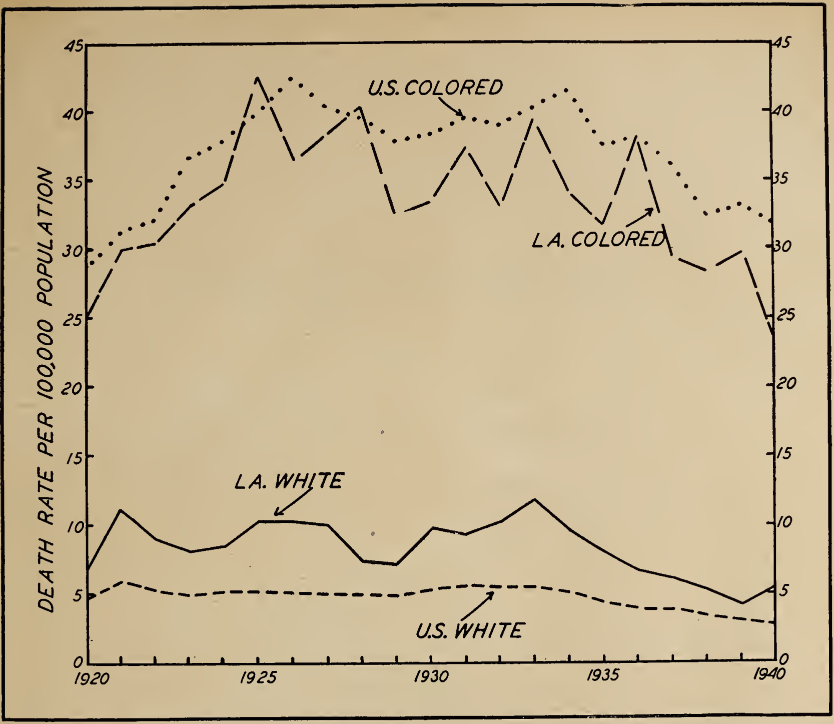

Figure 24. Annual Death Rates from Homicide, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

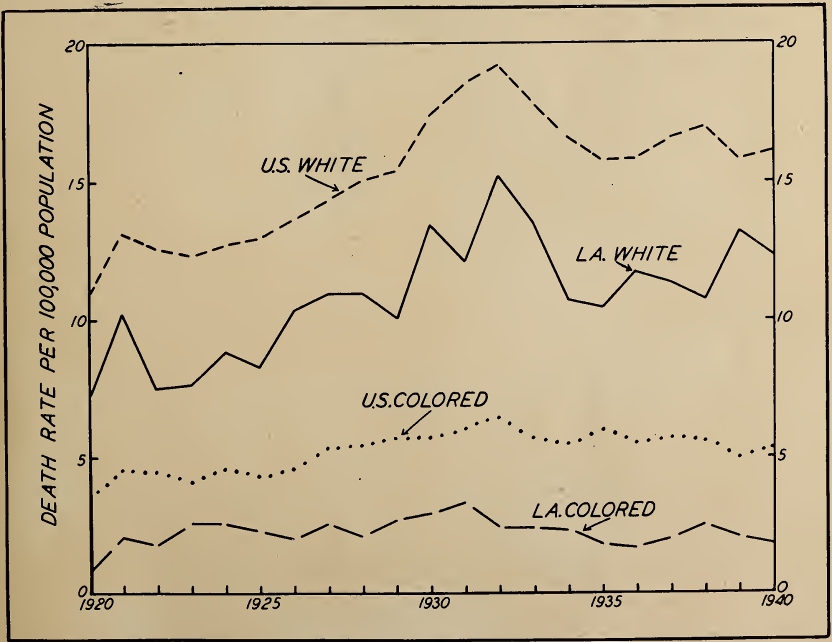

Figure 25. Annual Death Rates from Suicide, Louisiana and the United States Death Registration Area of 1920 for 1920 to 1940, by Race.

LOUISIANA BULLETIN NO. 391 JUNE, 1945

CAMELLIAS FOR THE YARD

By

W. D. KIMBROUGH AND C. E. SMITH

LOUISIANA STATE UNIVERSITY

AND

AGRICULTURAL AND MECHANICAL COLLEGE

AGRICULTURAL EXPERIMENT STATION

W. G. TAGGART, *Director*

SUMMARY

1. Get wanted varieties even if the initial cost is somewhat high. Camellias can live and give satisfaction for a long time and their potential value increases rather rapidly.

2. Plant in good location where there is good drainage and, if possible, partial shade.

3. Add organic matter to the soil and make the soil acid with aluminum sulphate.

4. Set the plant no deeper than it was in the nursery row. Do not plant too deep, nor on a high mound.

5. Apply fertilizer in late winter.

6. Mulch the plants, especially when they are small.

7. Water thoroughly at about weekly intervals during periods of drouth. This is especially important the first two years after transplanting.

8. Spray to control insects and diseases.

CAMELLIAS FOR THE YARD

By

W. D. Kimbrough and C. E. Smith

Interest in camellias has increased greatly in the last few years. Indications are that more and more people, especially men, will be interested in these plants. Consequently, there is considerable demand for information on how to take care of the plants. Many camellia enthusiasts have had little experience or knowledge concerning plant growth and as camellia plants are relatively expensive, it seems advisable to give some information that may be helpful. There are many notions about the care that camellias should be given and it is difficult for a beginner to know just what advice to take. The material here presented is not based on experimental evidence but on experience, observations, and other available information. It may not be of much value to the experienced camellia grower, but it should be helpful to those new at the game and will prevent many costly mistakes.

Varieties

There are many camellia varieties and the nomenclature is considerably mixed at the present time. Many varieties have more than one name and different kinds may be called the same variety. This causes some confusion when it comes to deciding what varieties to plant. It is best to see a variety in bloom to be sure that it will suit an individual taste, for there are many types and colors of camellias and considerable difference of opinion as to which are best. In the average yard there are locations for only a limited number of plants and the kinds that are to be set out should be selected with care. A poor type will take up space that could be occupied by a more desirable one. A camellia fancier would do well to take time and carefully consider varieties and maybe go to more expense at the start and get the varieties liked best instead of wasting space and time on varieties that are inferior. If a camellia plant is in a proper location and receives proper attention it should easily out live the person planting it. Plants over a hundred years old are not uncommon.

Varieties vary somewhat in the type of growth that they make. Some, such as Ruba Virginalis, Enrico Bettoni, Prof. Sargent, and Prince Eugene Napoleon, tend to make an upright growth and others, including Monarch, Gov. Mouton, Victor Emmanuel, and Bealei Rosea, tend to be of a spreading growth type. Still others, as Pink Perfection and Alba Plena, are intermediate. The type of growth should be considered in locating the place to set a plant. Some varieties grow more rapidly than others. Daikagura, Glen 40, and Lady Hume's Blush are examples of rather slow growers. Varieties that bloom profusely when quite small, such as Pink Perfection, do not grow as fast as those varieties that are shy bloomers when young. Also, some varieties will not be satisfactory because the blooms will often not open as they should. Mathotiana Alba is an example of this type and planting in the shade is best for this variety. Prof. Sargent does well when grown in full sunlight. Some varieties stand the cold better than others and still produce uninjured blooms. Gov. Mouton, Herme, and Prof. Sargent are examples of this type. The double imbricated Pink Perfection and Alba Plena type flowers seem to be easily injured in the bud stage and, though they may bloom fairly well, will have brown centers when fully open if they have been injured by cold. The Purple Dawn blooms seem to be especially susceptible to cold damage.

Camellia varieties vary to some extent in the length of the blossoming period. Some open many flowers at one time, while others produce a scattering of blooms over a long period. Camellia blooms that open during warm weather are not apt to be very satisfactory. When several varieties are to be planted it would be well to get varieties that would extend the blooming season over a long period. Diakagura is a very early blooming variety. Blooms of Alba Plena, Pink Perfection, and Purple Dawn start to open early. Prof. Sargent, Prince Eugene Napoleon, Gov. Mouton, Herme, and Monarch are examples of mid-season varieties. Victor Emmanuel, Bealei Rosea, Mathotiana Alba, and Sarah Frost are examples of late varieties. Empress of India is an example of a very late type.

The price of a camellia variety is not necessarily an indication of its desirabiliity, but is more often an indication of the ease of propagation or the supply of the stocks on hand. The better varieties will in general be somewhat higher, however, than inferior kinds. There is a tendency for camellia fanciers to accumulate a large number of varieties. That is all right for those with large estates, but for the average yard it is impossible to have all the kinds that may be desired. The urge, however, to get an unreasonable number of varieties is quite strong and those just starting to plant camellias are warned against it.

No attempt will be made to tell anyone what variety should be planted because there is too much individual preference as to likes and dislikes. Some varieties are especially good for corsages and house decorations while others are quite showy on the bushes. Some of the varieties that will probably be found to be satisfactory are as follows: Pink Perfection, Alba Plena, Purple Dawn, Gov. Mouton, Prince Eugene Napoleon, Debutante, Prof. C. S. Sargent, Chandleri Elegans, Col. Firey, C. M. Hovey, Laurel Leaf, and Bealei Rosea. The following varieties make a good display on the bush: Herme, Browns Red, Jarvis Red, Gloire de Nantes, Leucantha, Rubra Virginalis, and Empress. There are many other excellent varieties. No attempt will be made to describe varieties for descriptions can be found in nursery catalogues. Disappointment may follow the selection of varieties from descriptions only.

Planting

It has been said that camellias can be transplanted at any time of the year and this is probably true if the plant is moved with a good ball of soil and is properly handled. Best results, for the average person, will be obtained, however, if plants are set out during the winter or early spring. Roots may continue to grow during the winter and plants that are set out early are likely to be better established when growth starts than those set out later. It is best to select the places where the plants are to be set out well in advance of the time of planting. The hole should be dug and some decayed organic matter and aluminum sulphate worked into the soil as the hole is refilled. A little superphosphate put at the bottom of the hole should also be beneficial. If the holes are prepared in advance, transplanting can be done better and more easily. A plant should be set out so that when the soil settles it will be no deeper in the soil than it was in the nursery row. It is very important not to set the plants out too deep. There is little doubt that many excellent camellia plants have been lost simply because those setting them out have tried to do too good a job, as they thought, and have set the plants too deep. Usually such plants will live for awhile but do not grow normally and slowly die. Because of this fact some go to the other extreme and recommend that camellias be set on raised mounds. There is no advantage to this procedure on well drained soil and it can easily be carried to an extreme with harmful results. There is some advantage in planting on a mound or ridge if drainage is not too good. Burlap does not need to be removed from balled plants, but it can be if there is no danger of the ball of soil breaking. It is best not to transplant when the soil is muddy, but in any case the plants should be thoroughly watered after they are transplanted. Smaller plants are sometimes shipped barerooted. These plants may have more roots than balled and burlapped ones and are probably satisfactory if handled properly. They should be planted in December, if possible. If camellia plants are large enough, they should be set out in the place where they are to be left permanently, for moving the plants is not beneficial unless they are moved to a more favorable location.

Special care should be taken when small plants are transplanted to a permanent location to allow enough space between plants and between plants and buildings. Camellia plants should live a long time and this means that they will need space in which to grow. They should not be planted less than six feet apart, or from buildings, if they are expected to be left in one place for any length of time. Fast growing, spreading kinds have crowded at Baton Rouge in eight years when grown from 18 inch plants, set six feet apart.

Location

Good drainage is the first essential of a good location. If the soil is not well drained, the growing of camellias in it will not be satisfactory.

When the drainage is only fairly good the plants may live and grow very well for a time, but in very wet seasons are very likely to die. Also in periods of severe drouth, plants that are grown in soil that is not well drained are likely to suffer because they will have shallow root systems that can not supply the water needed. Setting plants on mounds may be of some help when drainage is not what it should be. This is more or less a temporary help and will not take the place of good drainge. Many excellent camellia plants die every year because they are planted in poorly drained soil.

If hardpan, an impervious layer of soil, occurs near the surface, normal root growth will be interfered with and plants will suffer during periods of drouth. Where hardpan occurs is not a good location for camellias.

Partial shade is essential for small camellia plants and some shade is beneficial to larger ones. Plants less than 18 inches tall should receive protection from the sun. They may be grown in a lath house, or on the shady side of a house, or given special protection if planted in the open where they are expected to grow permanently. Plants grown in partial shade may be expected to thrive better than those in full sun. Those grown in dense shade, however, should not be expected to make normal growth or bloom profusely.

As camellias bloom at a time when there may be injury from cold, locations that give some protection from cold are desirable.

Soil

Camellias will grow on a wide range of soils but they are not well adapted to very heavy types. In any case a high percentage of organic matter should be present. This may be supplied in the form of leaf or woods mold, or from well decomposed manure to which no lime or other chemical has been added. Cow manure is preferable to other manures. Usually the decaying mulch will supply sufficient organic matter after plants are established. In some localities the soil is of such a heavy type that a specially prepared soil in which to set out camellia plants is used. The soil is removed from a large size hole and a mixture is made of soil, organic matter, sand, and peat moss or similiar material. The composition of the mixture may vary to some extent. A mixture of ½ soil, ¼ leaf mold, and ¼ peat moss has been found to be satisfactory in some cases. Soils that contain considerable amounts of undecayed organic matter are likely to settle and due allowance for this should be made at planting time. Where specially mixed soil in which to plant camellias has to be used, the expense of planting is increased considerably and the plants are not likely to thrive over as extended a period of time as where suitable soil is found naturally. Instead of using an artificial mixture of soil, which may settle appreciably, it would be better to use hauled-in suitable soil if this can be done. The size of the hole into which prepared or hauled-in soil is placed would, of course, affect the duration of satisfactory growth.

A rather acid soil is required for camellias. The degree of acidity should range from pH 4.5 to 5.5. The degree of acidity is reflected somewhat in the type of growth that is made. It may also affect the intensity of the color of the flowers. In very acid soils the plants tend to be more compact and the rate of growth is slower than it is on plants in less acid soils. If soils are not sufficiently acid the plants are unhealthy, the growth is slow, and the leaves do not have a healthy green color. Unless this condition is corrected the plants will die. If the soil is not as acid as it should be, the best method of increasing acidity is by the application of aluminum sulphate. This may be applied at rates not exceeding ½ pound per square yard of surface. The rate of ¼ pound per square yard should usually be enough at a time. If applied before the plants are set out, it should be well mixed with the soil. After the plants are established it may be scattered over the surface of the soil around the plant. A good watering after the application of aluminum sulphate will hasten its effectiveness. If plants are unhealthy due to the pH of the soil being too high, applications of aluminum sulphate should be made at six week intervals until a marked improvement is shown in their appearance. The proper use of aluminum sulphate is often of paramount importance in obtaining satisfactory growth of plants. In many cases this material should be applied every year and sometimes twice a year as a normal practice. It is not a fertilizer, but may be mixed and applied with fertilizer. If bought in hundred pound lots, its cost is not excessive. The soil can be made too acid for camellias, if an excessive amount of acid forming material is applied.

Flowers of sulphur may be used for acidifying the soil. It is probably not as quickly effective as aluminum sulphate and must be used more carefully for one pound of sulphur will make approximately three times as much acid in the soil as a pound of aluminum sulphate.

There may be places in a yard, especially around buildings, where lime was spilled when the house was built. These places must receive special attention if camellias are to be grown there. The lime should be removed if possible and acid forming material applied.

Fertilizer

Certain elements are essential for plant growth. The plant obtains most of these elements from the soil and they must all be present in an available form in sufficient quantity if best growth is to be obtained. If a soil can meet these requirements, no fertilizer is necessary. Unfortunately, especially in the South, there is usually a deficiency of one or more of these essential elements. They are usually added in some form of fertilizer. To the inexperienced, the application of fertilizer is a rather mysterious and difficult procedure. Actually, with a little practice, it is very simple. Most commercial mixed fertilizers, such as 4-12-4 or 5-10-5, are rather concentrated materials and can be very injurious to plants if applied in too large amounts. The beginner should not apply the ordinary mixed fertilizers at rates exceeding ½ pound to the square yard and it should be well scattered over the surface of the soil. It should be applied under the mulch and may be worked lightly into the soil. Watering after an application of fertilizer makes it more readily effective and also lessens the chances of injury. The residual effect on the soil of the fertilizer used should be acid rather than alkaline. This means that fertilizers that have dolometic limestone added as a filler should preferably not be used on camellias. A fertilizer that is neutral in reaction will tend to reduce the acidity of an acid soil. Cottonseed meal is often used and recommended as a fertilizer for camellias. It is a little safer for the beginner to use as it is an organic form and not as likely to be used in amounts that might be injurious. It, however, is considered mainly to be a source of nitrogen and, though it does contain other needed elements in relatively small amounts, it may not supply them in sufficient quantity. The composition of cottonseed meal is somewhat variable, but the analysis of a fertilizer made of 6 parts of cottonseed meal, 3 parts of 18 per cent superphosphate, and 1 part of muriate or sulphate of potash would be approximately 4-8-6. This is suitable for use on camellias and is much better than using cottonseed meal alone. If an inorganic source of nitrogen is used on camellias, sulphate of ammonia is the best one to use as it increases the acid content of the soil. Not more than 1/10 pound of ammonium sulphate per square yard should be applied at one time. This should not be confused with aluminum sulphate.

The best time to appliy fertilizer to camellias is in the late winter or early spring. It should be applied far enough in advance of the first growth period to be utilized at that time. At this time growth is general over the bush, while later growths are usually just from some of the terminal buds. Except on very poor soils one fertilizer application per year should be sufficient. On very poor soil another application in the summer may be beneficial. Fertilizer should not be applied late enough in the year to stimulate growth late in the season, for such growth is very likely to be injured by cold. Late growth often can not be avoided, but nothing should be done to encourage it.

Camellias are generally thought to be plants that grow very slowly and this, no doubt, is often true. Many varieties of camellias in favorable conditions will, however, with proper care make a very rapid growth. Plants in good locations around Baton Rouge have grown from 18 inch plants to ones 6 to 8 feet tall in eight years. The Alba Plena variety which is said to make a slow growth, has grown very rapidly under favorable conditions. In fact it may grow so late in the season that it is susceptible to cold injury.

Watering

Though good drainage is essential for the well being of camellia plants, an abundance of water is also necessary. It is especially important that the plants must not suffer from insufficient water for the first two years after they are transplanted. The second year is especially important for that is when they are most likely to be neglected. When plants are watered, they should be thoroughly soaked and then not watered again for about a week. A little sprinkle of water every day or two does little, if any, good. Water may be alkaline in reaction, as it is in Baton Rouge, so plants that are watered extensively should be watched for symptoms resulting from alkaline soil. If these symptoms are noticed, corrective, measures as mentioned before will be necessary.

Mulching

The soil around camellias should not be cultivated except very lightly to keep down weeds and grass. A mulch of some kind should be kept around small plants until they are large enough to shade the ground around them. This is especially important for plants growing in full sunlight. The mulch is used for several purposes: it conserves moisture, tends to keep the surface soil cooler, helps to keep weeds and grass from growing, and reduces danger from cold injury to roots. The decaying mulch tends to keep a high organic matter content in the soil around the plants. A number of materials may be used, but those tending to have an acid reaction on the soil are best. Some of these are oak leaves, pine straw, peat moss, specially prepared bagasse such as Servall, and half rotted sawdust (cypress being preferable). New mulch should be put around the plants in the early spring after fertilizer has been applied if it has not been done previously.

Propagation

1. Cuttings

Camellias are propagated quite largely by cuttings. Wood of the current season's growth should be used for a cutting and it should be hard enough to break with a snap when bent. Commercially, cuttings are usually made in midsummer, but they may be made at any time the wood is suitable. If cuttings are made during the winter months, they will root better if heat is applied to the cutting bed. The cutting should be 4 to 5 inches long and the upper two to three leaves should not be removed.

The cutting bed should be in a well drained location, where it does not receive any direct sunlight. Cuttings will root in sharp sand but a mixture of about 2/3 sand and 1/3 peat moss is preferable. The rooting medium should cover about 2/3 of the length of the cutting. It is important that the cutting bed be kept moist at all times. The relative humidity must be kept very high because of the leaves left on he cuttings and for this reason cutting beds are often covered until the cutting start to grow. Rooting will usually occur more quickly if the cuttings are treated with one of the growth promoting substances. The directions given by the manufacturer should be followed. The materials sold as a dust are easiest to apply.

Cuttings are often rooted on a small scale by placing them in a shady location such as the north side of a building. Covering each cutting with a jar is often beneficial.

2. *Grafting*

The grafting of camellias commercially and by individual camellia fanciers is becoming more important. This is especially true for the more expensive varieties. Except for weak growing varieties there is no advantage to having grafted plants. Because of the more extensive root system which is already established on the stock, grafts will usually grow more rapidly than a cutting. Grafted plants that are dug for transplanting lose part of this advantage, because of the loss of roots. Of course, undesirable varieties may, if successfully grafted, be changed to desired ones.

Camellia sasanquas or vigorous growing varieties of Camellia japonica such as Bealei Rosea, Sarah Frost, Prof. Sargent, etc. are used for grafting stock. Plants with single stems ½ to 1 inch in diameter are most suitable for grafting stock. Very large plants are more difficult to graft successfully. Terminal shoots that would be good for cuttings should be used as scions. The cleft graft is most generally used for grafting camellias. No detailed description of this type of graft will be given as it can be found in nearly any book or other publication on plant propagation. The stock should be cut off with a sharp saw about two inches above the ground. The stock should be split with a grafting tool or some other implement. The scion should be cut from a nearby plant or removed from water and dried and the bottom end sloped with a sharp knife and inserted as quickly as possible into the split in the stock so that the cambium layers of stock and scion coincide. The stock should be wrapped and cut surfaces and wrapping covered with melted paraffin or grafting wax which is not hot enough to cause injury. If the stock is large enough two scions may be placed in it. Two or three leaves should be left on the scion. If a large sized stock is grafted natural pressure on the scion may be too severe. This may be prevented by a wedge in the center of the split stock.

It is not particularly difficult to graft camellias, but there is no assurance that any particular graft will live. After the graft is finished, it should be covered with a glass jar or something similar to keep the humidity relatively high, and it should be protected from direct sunlight. Soil that will not pack or sand may be placed around the stock and cover part of the scion. This should be kept moist. The jar should be left on until first leaves unfold and should not be left off abruptly but for part of a day to start with and the interval increased until it can be safely left off entirely. The graft should still receive some protection from direct sunlight after the jar has been permanently removed. Growth of the scion may not start for from six to ten weeks after the graft is made. Scions may look for several weeks as if they are going to live and then finally die. February is probably the best month in which to graft camellias.

3. Seed

Camellias are propagated to some extent from seed. They will not, however, come true from seed and a large percentage of seedlings produce undesirable single blooms. There is always a slight chance that a seedling may be worth propagating as a new variety. Vigorous growing seedlings may be used as grafting stock. If seed is to be planted, it should be done soon after harvest, or seed should be stratified in moist sand until late winter when it should be planted.

Freeze Injury

Camellias are somewhat susceptible to injury from cold. The condition of the tree at the time of a freeze largely determines the extent of the injury. If plants are growing immediately prior to periods of low temperature there is likely to be injury. Nothing should be done to encouarge growth late in the season. There is some difference in varietial susceptibility to cold injury. Well developed buds may be injured by cold. The buds may drop or centers may become brown. A few days after a freeze buds may be cut and if they have been injured by cold there will be brown in the center of the bud.

Insects and Diseases

Camellias are often infested and may be severely injured by one or more of several species of insect. There are at least two diseases also which should be controlled. The time to spray or dust, spray or dust materials to use, and the insects and diseases to control are listed below.

Kind of Oil to Use: A medium-light highly refined mineral oil should be used in spraying camellias. These oils are usually referred to as "white-oil emulsion" or "Summer oil sprays". The one most commonly sold on the Baton Rouge market is known by the trade name of "Nursery Volck." Until recently it was a thin white paste or creamy emulsion having a consistency similar to mayonnaise. It contains 80% oil. Recently, this same oil under the same name has been placed on the market as a miscible oil which contains 97% oil.

SPRAY SCHEDULE FOR CAMELLIAS

TIME	DUSTS AND SPRAYS		FOR CONTROL OF
1. First of April	A. White-oil emulsion Water	1 gal. 50 gals.	Scales Mites
Alternate	(When disease control is desired). B. White-oil emulsion Bordeaux mixture	 1 gal. 4-4-50	Scales Mites Spaceloma Phomopsis
2. April 10 to 30 2 or 3 applications.	Bordeaux mixture	4-4-50	Spaceloma
3. May 1 to Sept. 1.	Dust with sulphur		Mite (microscopic)
4. Last of September 1st week of Oct.	White-oil emulsion Water	3 qts. 50 gals.	Scales Mites
Anytime insects appear	Nicotine sulphate Soap Water or 3% nicotine dust	½ pt. 3 lbs. 50 gals.	Aphids
	Cryolite (dust or spray)		Beetles Budworm

How to Spray: Each plant should be sprayed systematically and thorouhgly. Most of the spraying should be done with the nozzle directed upward so that the underside of the leaves will be covered. After this is accomplished the tops of the leaves can be quickly sprayed with a few sweeps of the nozzle. Plants should not be drenched.

Caution: Camellias should not be sprayed in winter, nor in summer when the temperature is likely to go above 95°F. Plants suffering from lack of moisture or lack of cultivation should not be sprayed. Do not spray first year transplanted plants with oil.

Always allow at least four weeks between sulphur and oil applications.

PROPORTIONS FOR MIXING CAMELLIA SPRAYS

Water	White-oil Emulsion		
	1-100	1½-100	2-100
1 gal	3 level tablespoons	4½ level tablespoons	6 level tablespoons
6 gal	½ pint	¾ pint	1 pint
12 gal.	1 pint	1½ pints	1 quart
50 gal.	½ gal.	3 quarts	1 gal.
100 gal.	1 gal.	1½ gal.	2 gal.

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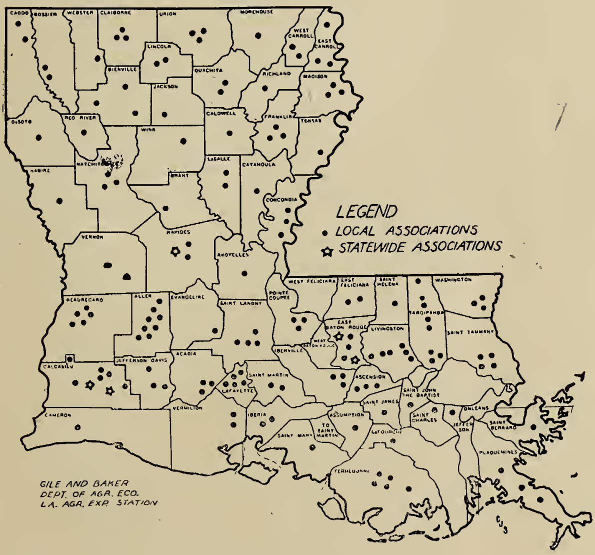
By

Bueford M. Gile and J. M. Baker

FARMERS' COOPERATIVE BUSINESS ASSOCIATIONS



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FARMERS' COOPERATIVE BUSINESS ORGANIZATIONS IN LOUISIANA

By

BUEFORD M. GILE AND J. M. BAKER

By means of a field survey during 1944, there were found in Louisiana 152 farmers' cooperatives, of which 147 were local or district associations. Among the local units. six were in process of organization and seven were reported by officers as temporarily inactive on account of war conditions, leaving 134 local associations active in 1944. The five state-wide organizations of the centralized or federated type were all active, and usually served farmers through local units.

The list of farmers' cooperative business associations given in this report does not include many group organizations, cooperative in nature, whose functions are largely educational and promotional from a public service point-of-view. The data refer specifically to cooperative associations of farmers engaged in processing or marketing the products grown by them and in purchasing or manufacturing supplies used by them in the process of producing farm products. In general, the associations reported are incorporated, have a board of directors, an established place of business; and operate on the basic cooperative principles of one vote per member, limited returns on capital investment, and the distribution of surpluses on the basis of patronage. Farmers' cooperative credit associations are not included.

The 147 local associations reported a total of 41,060 patrons, of which 36,000 were voting members and 5,060 were patrons who had not satisfied all the requirements necessary to become voting members. It is estimated that 8,060 of the farmer participants reported were members of more than one association. After making deductions of membership duplications, there were 33,000 Louisiana farmers associated with a cooperative business organization. The data show that about one-third of owner and manager tenant farmers in Louisiana were members of local business cooperative associations in 1944.

The distribution of farmers' cooperative business organiaztions is shown by the figure on the cover page. Each black dot represents the established office location for one association. In the case of all state-wide organizations and also for many of the local or district associations, the membership is not confined to the particular parish in which the main office is located. Farmers' cooperative business associations are found in all parts of Louisiana, but they are more numerous in the sugarcane, rice, strawberry, and truck crop areas than in those areas where cotton is the main cash crop.

Although many of the local associations perform more than one activity many of them concentrate on one main type of service. Local units which operate "across the board" were not found, but a study of the nature of the functions performed shows that some of the associations are expanding in that direction. Because of the highly seasonal nature of the processing and marketing of most farm products in Louisiana, a combination of enterprises which would lengthen the number of months of active business should make the retention of a well qualified manager throughout the year economically more feasible.

Thirty-three different points were found in Louisiana where some cotton lint was marketed cooperatively in 1944 (Table 1). The volume of cotton marketed at most of the places was small, but the fact that the cooperative outlets existed tends to narrow the margin between the local and the central cotton markets. There are 13 points where cooperative outlets for truck crops were found, nine for strawberries, eight for raw sugar and molasses, seven each for rice and poultry products, and six for wool. Although there were only three active milk marketing associations, their influence is widespread. The bargaining agency for milk producers in the New Orleans milkshed is located at Kentwood and has 2,000

TABLE 1—Louisiana: Number of items found and nature of busines done by local cooperative business organizations of farmers during 1944[1]

Marketing		*Processing*		*Farm supplies (purchasing)*	
No.	*Product*	*No.*	*Nature*	*No.*	*Nature*
33	Cotton lint	8	Sugarcane factory	35	Fertilizer
8	Cottonseed	8	Cotton gin	30	Seeds
16	Potatoes (sweet and Irish)	6	Freezer-locker plant	15	Feeds
13	Miscellaneous truck crops[2]	2	Rice dryer	13	Electric current
10	Strawberries	3	Wash, color, wrap and pack oranges and other citrus fruits	7	Retail store or warehouse
8	Raw sugar and molasses	2	Pasteurizing and packaging milk	6	Insecticides
7	Poultry and eggs	2	Pre-cooling machine for cars	6	Containers (wood)
7	Rice	2	Feed grinder and mixer	5	Fruit jars and cans
6	Wool	1	Cottonseed oil refinery	5	Baby chicks
3	Watermelons	1	Tung oil refinery	5	Rice irrigation water
3	Milk wholesale	1	Wash, grade and pack potatoes	4	Bags and twine
1	Cream (shipping)	1	Small cane syrup mill	3	Dairy equipment and supplies
1	Lespedeza seed	1	Peanut picker	2	Health service
1	Peanuts	1	Feed dryer	1	Grazing rights
1	Pelts (fur bearing animals)			1	on levee
1	Paprika				
1	Easter Lily bulbs				

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[1] Many associations render more than one type of service.
[2] Green beans, cucumbers, green peppers, eggplant, cabbage, carrots, tomatoes, shallots, etc.

members. It is accomplishing its purpose of obtaining for its members a larger share of the price paid for milk by consumers. The milk association in the Monroe milkshed operates truck routes in several parishes to assemble the milk from producer members. This association has been successful in reducing the price margin between the farmer and the consumer and in lowering the costs of milk concentration. The association of milk producers at DeRidder is small, but it has benefited not only its members but also the consumer by providing a supply of pasteurized milk.

Developments in the field of processing farm products are relatively new, but have been generally successful. Processing plants require a larger investment of capital than is found in most associations organized primarily for marketing purposes. Louisiana has eight cooperative mills for processing cane and manufacturing raw sugar and the same number of cooperative cotton gins. The cooperative gins usually market cottonseed but not the cotton lint. One drying plant for rough rice operated at Sulphur, Louisiana, and two additional drying plants were constructed in 1944. All but one of the six freezer-locker plants found were in process of organization and construction. There is a cooperative tung oil crusher and refinery at Covington, and a cooperative cottonseed oil press and refinery at Washington in St. Landry Parish.

In the field of farm supplies, fertilizers and seeds are most frequently purchased cooperatively. There are 13 associations engaged in the construction of transmission lines and furnishing electric current to farmers. The cooperative farmers' electric power associations supplied electric current to 15,654 rural families on January 1, 1945. This enables them to enjoy the conveniences of electric lights, refrigerators, and other household and farm equipment operated by electrical power. Five cooperative rice irrigation systems were found in use in Allen Parish. The irrigation associations collected the same share of the rice produced as is paid to private irrigation companies in the rice area and partly due to wartime prices for rice, their financial progress has exceeded expectations.

In Table 2 which constitutes the remainder of this bulletin, the name and location of farmers' cooperative business organizations operating in Louisiana in 1944 are shown. Following the name of each organization a brief summary of the nature of the services performed is given. In Part 2 of Table 2, the local or district associations are listed by parishes. This will enable farmers to find quickly the organizations located in their home parish and in neighboring parishes. It will also enable them to gain a better understanding of cooperative developments in all sections of Louisiana.

TABLE 2—Louisiana: Farmers Cooperative Business Organizations. Name, Office Location, and Nature of Business, 1944

Part 1. Louisiana: State or regional area cooperative units.

	Name and office location	*Nature of business*
1.	American Rice Growers Coop. Assn. Inc. **Lake Charles**	Rice marketing — foreign and domestic sales service — milling — warehousing — financing — packaging—grading — seed testing — certification. Serves seven local or divisional units in Louisiana and eight in Texas.
2.	American Rice Growers Exchange. **Lake Charles**	Wholesales farm supplies to local or divisional rice associations.
3.	Louisiana Agricultural Coop. Inc. 1175 Choctaw Rd. **Baton Rouge**	Farmers purchasing cooperative, handling principally seeds, fertilizers, and insecticides.
4.	Cooperatives of Louisiana. **Baton Rouge**	Markets cotton on brokerage basis. Operates box and crate factory at Hammond. Wholesales fertilizer, seeds, feeds, hardware, and miscellaneous supplies used in farm production to members of local cooperatives.
5.	Farmers State Exchange **Pineville**	Centralized purchasing and marketing organization. Operates through local units known as purchasing and marketing associations.

Part 2. Louisiana: Cooperative associations operating largely within a parish or a small group of parishes.

	Name and office location	*Nature of business*
	ACADIA PARISH	
1.	American Rice Growers Cooperative Assn. **Crowley**	Rice marketing service.
2.	Crowley Rice Dryer, Inc. **Crowley**	Rice drying plant.
3.	Acadia Pur. and Mktg. Assn.[1] **Crowley**	Sells cotton, sweet potatoes, Irish potatoes; handles orders for seeds, chicks, and fertilizer. Has cotton gin near Church Point.

[1] All purchasing and marketing associations are local units of the Farmers State Exchange at Pineville, Louisana.

	Name and office location	*Nature of business*
	ALLEN PARISH	
1.	Allen Parish Sheep and Wool Growers Assn. **Oberlin**	Arranges for wool auctions and the assembly of wool for shipping.
2.	Allen Parish Pur. and Mktg. Assn. **Oakdale**	Sells cotton, Irish potatoes, and handles orders for feed, fertilizer and garden seed.
3.	Darbonne Coop. Irrigation Assn. **Oakdale**	Irrigation system for rice.
4.	Soileau Coop. Irrigation Assn. **Oakdale**	Irrigation system for rice.
5.	Sonnier Coop. Irrigation Assn. **Oakdale**	Irrigation system for rice.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

Name and office location	*Nature of business*
6. Fontenot Coop. Irrigation Assn. **Oakdale**	Irrigation system for rice.
7. Granger Coop. Irrigation Assn. **Oakdale**	Irrigation system for rice.
8. Allen Parish Medical Assn. **Oakdale**	Medical Service.
ASCENSION PARISH	
1. Ascension Farmers Coop Assn. Inc. **Gonzales**	Markets green beans and strawberries and handles seeds, fertilizers and insecticides.
2. Ascension Mktg. Service Inc. **Gonzales**	Markets poultry and eggs and handles feed. Has truck for gathering eggs from farms.
3. Evan Hall Sugar Coop. **McCall**	Sugarcane mill. Handles fertilizer and soybean seed. Markets raw sugar and molasses.
ASSUMPTION PARISH	
1. Glenwood Cooperative. **Napoleonville**	Sugarcane mill. Markets raw sugar and molasses.
AVOYELLES PARISH	
1. Avoyelles Pur. and Mktg. Assn. **Marksville**	Sells cotton and takes orders for seed and fertilizer.
BEAUREGARD PARISH	
1. Beauregard Wool Growers Assn. **DeRidder**	Pools wool and holds auction sale.
2. DeRidder Coop. Dairy. **DeRidder**	Pasteurizes, bottles and sells milk wholesale; handles milk cans, dairy equipment and supplies.
3. Beauregard Electric Coop. **DeRidder**	Supplies electrical energy.
4. DeRidder Frozen foods. **DeRidder**	Freezer-locker plant.[1]
5. Beauregard Parish Pur. and Mktg. Assn. **DeRidder**	Sells cotton and retails farm supplies from local store.

[1] Incorporated and in process of organization in 1944.

BIENVILLE PARISH	
1. Northwest Louisiana Agricultural Assn. **Saline**	Handles fertilizer and potato seed.
2. Bienville Parish Pur. and Mktg. Assn. **Arcadia**	Markets cotton.
3. Woodardville Farmers, Inc. **Ringgold**	Markets cotton, handles seeds and fertilizer.
BOSSIER PARISH	
1. Bossier Parish Pur. and Mktg. Assn. **Bossier City**	Operates cotton gin, sells cotton and cottonseed; handles seed, feed, fertilizer, fruit jars and cans.
2. Bossier Rural Electric Membership Coop. **Bossier City**	Builds transmission system and supplies electric current to farms and rural establishments.
CADDO PARISH	
1. North Caddo One-Variety Cotton Assn. Inc. **Gilliam**	Sells cotton through broker.[1]
2. Caddo Parish Pur. and Mktg. Assn. **Rodessa**	Markets cotton.

[1] Not active in 1944 on account of war conditions.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

Name and office location	*Nature of business*
CALCASIEU PARISH	
1. American Rice Growers Coop. Assn. (Holmwood District) **Lake Charles**	Rice marketing service. Handles sacks, twine and fertilizer.
2. Sulphur Rice Coop. Inc. **Sulphur**	Dries, stores and markets rice. Handles sacks, twine and fertilizer.
3. American Rice Growers Coop. Assn. **Iowa**	Rice marketing service. Handles sacks, twine, and fertilizer.
4. La. Sheep and Wool Growers Coop. Assn. Inc. **Lake Charles**	Arranges for wool auctions and the pooling of wool for shipment.
5. DeQuincy Wool Growers Coop., **DeQuincy**	Arranges for wool auctions and the pooling of wool for shipment.
6. Calcasieu and Cameron Pur. and Mktg. Assn. **Lake Charles**	Inactive in 1944.
CALDWELL PARISH	
1. Caldwell Parish Pur. and Mktg. Assn. **Columbia**	Markets cotton, Irish potatoes and takes orders for seeds and fertilizers.
CAMERON PARISH	
1. Jefferson Davis Electric Coop., Inc. **Cameron**	Builds transmission system and supplies electric current to farm and rural establishments.
CATAHOULA PARISH	
1. Catahoula Pur. and Mktg. Assn. **Jonesville**	Markets cotton.
CLAIBORNE PARISH	
1. Claiborne Refrigeration Coop. Inc. **Homer**	Freezer-locker plant.[1]
2. Claiborne Parish Pur. and Mktg. Assn. **Homer**	Markets cotton.
3. Claiborne Electric Coop. Inc. **Homer**	Builds transmission systems and supplies electric current to farms and rural establishments.
CONCORDIA PARISH	
1. Concordia Mktg. Service, Inc. **Monterey**	Sells eggs, potatoes, cream; handles seed, feed and fertilizer.
2. Concordia Electric Coop. Inc. **Ferriday**	Builds transmission system and supplies electrical current to farms and rural establishments.
3. Concordia Pur. and Mktg. Assn. **Ferriday**	
DESOTO PARISH	
1. DeSoto Parish Pur. and Mktg. Assn. **Mansfield**	Markets cotton and conducts health service.
EAST BATON ROUGE PARISH	
1. East Baton Rouge Parish Agricultural Coop. Inc. **Baton Rouge**	Feed, seed, fertilizer and farm supply store.
2. Dixie Electric Membership Corp. **Zachary**	Builds transmission system and furnishes electric current to farms and rural establishments.
3. Ascension and East Baton Rouge Pur. and Mktg. Assn. **Baton Rouge**	Markets cotton and takes orders for fertilizer and seeds.

[1] Incorporated and in process of construction in 1944.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

	Name and office location	*Nature of business*
	EAST CARROLL PARISH	
1.	Transylvania Coop. Gin Assn. **Transylvania**	Gins cotton. Sells cottonseed; handles grazing rights on levee.
2.	Madison and East Carroll Gin Assn. **Roosevelt**	Gins cotton and sells cottonseed.
3.	East Carroll Pur. and Mktg. Assn. **Lake Providence**	Markets cotton and handles orders for feeds, seeds and baby chicks.
	EAST FELICIANA PARISH	
1.	East Feliciana Parish Pur. and Mktg. Assn. **Clinton**	Markets cotton and lespedeza seed. Takes orders for fertilizer and seed potatoes.
2.	Ethel Mktg. Coop. **Ethel**	Markets eggs.
	EVANGELINE PARISH	
1.	Evangeline Pur. and Mktg. Assn. **Ville Platte**	Markets cotton, sweet potatoes and Irish potatoes.
	FRANKLIN PARISH	
1.	Farmers Cooperative Gin, Inc. **Winnsboro**	Gins cotton and markets cottonseed. Supplies hulls and meal to members during the ginning season.
2.	Franklin Parish Pur. and Mktg. Assn. Inc. **Winnsboro**	Markets cotton and takes orders for farm supplies.
3.	Northeast La. Power Coop. Inc. **Winnsboro**	Builds transmission system and supplies electric current to farms and rural establishments.
	GRANT PARISH	
1.	Grant Parish Pur. and Mktg. Coop. **Colfax**	Markets cotton. Takes orders for feed, seeds and fertilizer.
	IBERIA PARISH	
1.	Iberia Sugar Coop. Inc. **New Iberia**	Sugarcane mill — sells raw sugar and molasses, dry soybeans, oats, etc.
2.	Iberia Pur. and Mktg. Assn. **New Iberia**	Markets Irish potatoes and takes orders for seeds and fertilizers.
	IBERVILLE PARISH	
1.	St. Louis Sugar Coop. Inc. **Plaquemine**	Sugarcane mill — markets plantation granulated sugar and molasses.
2.	White Castle Farmers Coop. **White Castle**	Markets shallots, Irish potatoes and other vegetables. Sells farm supplies of many kinds.
3.	Iberville and West Baton Rouge Pur. and Mktg. Assn. **Plaquemine**	Inactive during 1944.
	JACKSON PARISH	
1.	Jackson Parish Pur. and Mktg. Assn. **Jonesboro**	Markets cotton, potatoes and tomatoes. Takes orders for fertilizer and seeds.
	JEFFERSON PARISH	
1.	Jefferson Parish Pur. and Mktg. Assn. **Gretna**	Packs oranges and handles insecticides.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

Name and office location	*Nature of business*
JEFFERSON DAVIS PARISH	
1. American Rice Growers Coop. Assn. **Welsh**	Markets rice — handles sacks, twine, seed, rice and feed.
2. American Rice Growers Coop. Assn. **Elton**	Markets rice — handles bags, fertilizer, twine.
3. Jeff. Davis Parish Pur. and Mktg. Assn. **Jennings**	Inactive during 1944.
LAFAYETTE PARISH	
1. Carencro Sweet Potato Coop. Inc. **Carencro**	Markets sweet potatoes .
2. Lafayette Dairymen Coop. Inc. **Lafayette**	Handles seed, feed, fertilizer and miscellaneous supplies.
3. Ossun Sweet Potato Coop. Inc. **Ossun**	New 1944. Organized to wash, grade, store, sell, and ship sweet potatoes for members.
4. Southwest La. Electric Membership Corp. **Lafayette**	Builds transmission system and furnishes electric current to farms and rural establishments.
5. Lafayette Pur. and Mktg. Assn. **Lafayette**	Markets sweet potatoes.
LAFOURCHE PARISH	
1. Lafourche Parish Pur. Assn. **Thibodeaux**	Markets cotton and vegetables. Takes orders for fertilizer, seeds, cans, jars, and baby chicks.
LASALLE PARISH	
1. LaSalle Parish Pur. and Mktg. Assn. **Jena**	Operates cooperative store for farm supplies.
2. LaSalle Parish Cattlemen's Assn. **Jena**	Purchases feed.
LINCOLN PARISH	
1. Lincoln Mktg. Service Inc. **Ruston**	Frozen food locker plant.[1]
2. Lincoln Parish Pur. and Mktg. Assn. **Ruston**	Markets cotton, potatoes, peanuts, watermelons and certified cottonseed. Takes orders for farm supplies.

[1] In process of organization in 1944.

LIVINGSTON PARISH	
1. First Hungarian Farmers. **Albany**	Markets strawberries, beans, cucumbers, eggplant and all truck crops. Has warehouse and handles fertilizer, seeds, insecticides and containers.
2. United Hungarian. **Albany**	Markets strawberries and all truck crops. Has warehouse and handles fertilizer, seeds, insecticides, and containers.
3. Holden Farmers Assn. Inc. **Holden**	Markets strawberries and all truck crops. Has warehouse and handles fertilizer, seeds, insecticides, and containers.
4. Springfield Farmer's Coop. **Springfield**	Markets strawberries and all truck crops. Has warehouse and handles fertilizer, seeds. insecticides, containers and farm machinery.
5. Doyle Community Service. **Doyle**	Cane mill, grist mill, and handles farm supplies.[1]
6. Livingston Parish Pur. and Mktg. Assn. **Denham Springs**	Inactive during 1944.

[1] In process of organization in 1944 — waiting for power.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

	Name and office location	*Nature of business*
	MADISON PARISH	
1.	Mound Coop. Gin. **Mound**	Gins cotton and markets cottonseed.
2.	Tallulah Coop. Gin. **Tallulah**	Gins cotton and markets cottonseed.
3.	Madison Parish Pur. and Mktg. Assn. **Talulah**	Markets cotton.
	MOREHOUSE PARISH	
1.	Morehouse Pur. and Mktg. Assn. **Bastrop**	Markets cotton.
	NATCHITOCHES PARISH	
1.	Natchitoches Mktg. Service **Natchitoches**	Freezing and locker plant — sells poultry and eggs.
2.	Valley Electric Membership Coop. **Natchitoches**	Builds transmission lines and furnishes electric current to members.
3.	Natchitoches Parish Pur. and Mktg. Assn. **Natchitoches**	Markets cotton.
	OUACHITA PARISH	
1.	Cooperative Dairies. **Monroe**	Transports milk from farms. Pasteurizes and wholesales market milk in containers.
2.	Ouachita Parish Pur. and Mktg. Assn. **Monroe**	Markets cotton.
	PLAQUEMINES PARISH	
1.	Buras Citrus Growers Coop. **Buras**	Washes, grades, colors and packs citrus fruits. Handles boxes, crates and other packing material.
2.	Orange Growers Coop. Assn. **Boothville**	Washes, grades, colors and packs citrus fruits.
3.	Plaquemines Parish Pur. and Mktg. Assn. **Pointe-a-la-Hache**	Markets hides from fur bearing animals.
	POINTE COUPEE PARISH	
1.	Pointe Coupee Mktg. Service Inc. **New Roads**	Markets eggs.
2.	Pointe Coupee Pur. and Mktg. Assn. **New Roads**	Has storage warehouse and sells seed potatoes, chicken feed, etc. Markets cotton and Irish potatoes.
3.	Pointe Coupee Electric Membership Corp. **New Roads**	Builds transmission system and furnishes electric current to farms and rural establishments.
	RAPIDES PARISH	
1.	Central La. Farmers' Coop. Market **Alexandria**	Egg market, also watermelons and sweet potatoes.
2.	Rapides Parish Pur. and Mktg. Assn. **Alexandria**	Markets cotton and Irish potatoes; takes orders for fertilizer.
	RED RIVER PARISH	
1.	Red River Pur. and Mktg. Assn. **Coushatta**	Markets cotton and takes orders for seeds and fertilizers.
	RICHLAND PARISH	
1.	Richland Parish Pur. and Mktg. Assn. **Rayville**	Markets cotton.
	SABINE PARISH	
1.	Sabine Parish Pur. and Mktg. Assn. **Many**	Inactive during 1944.
	ST. BERNARD PARISH	
1.	St. Bernard Pur. and Mktg. Assn. **Arabi**	Inactive during 1944.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

	Name and office location	*Nature of business*
	ST. CHARLES PARISH	
1.	Waterford Sugar Cooperative, Inc. **Killona**	Sugarcane mill, grinds cane, makes and markets sugar and molasses. Handles pea and bean seeds and fertilizer.
	ST. HELENA PARISH	
1.	St. Helena Parish Pur. and Mktg. Assn. **Greensburg**	Orders taken for seeds.
	ST. JAMES PARISH	
1.	Helvetia Sugar Coop. Inc. **Central**	Sugarcane mill. Markets raw sugar and molasses. Handles fertilizer and hardware for accomodation of members.
	ST. JOHN PARISH	
1.	St. John, St. James and St. Charles Pur. and Mktg. Assn. **Edgard**	Markets potatoes and handles fertilizer.
	ST. LANDRY PARISH	
1.	Swords Cooperative Gin. Inc. **Swords**	Gins cotton and delivers cottonseed to cooperative oil mill at Washington. Handles cottonseed meal. Gin located at Swords.
2.	St. Landry Soybean Coop. Inc. **Washington**	Oil compress. Sells cottonseed cake, soybean meal, and handles feeds.
3.	Cooperative Paprika Mills Inc. **Opelousas**	Sells paprika (In process of organization in October 1944).
4.	St. Landry Pur. and Mktg. Assn. **Opelousas**	Markets sweet potatoes and cotton.
	ST. MARTIN PARISH	
1.	Breaux Bridge Sugar Coop. Inc. **Breaux Bridge**	Sugarcane mill. Sells raw sugar and molasses.
2.	St. Martin Pur. and Mktg. Assn. **St. Martinville**	Markets sweet potatoes.
	ST. MARY PARISH	
1.	Teche Electric Coop. Inc. **Centerville**	Constructs transmission lines and furnishes electric current to farms and rural establishments.
	ST. TAMMANY PARISH	
1.	Growers Cooperative Assn. **Covington**	Freezer locker plant.[1] Operates a peanut picker. Handles seeds.
2.	Ozone Tung Oil Producers Assn. **Covington**	Crushes tung oil nuts and refines oil. Sold product to U. S. Government for past three years.
3.	Southeast La. Wool Growers, Inc. **Covington**	Pools wool and sells at auction.
4.	St. Tammany Pur. and Mktg. Assn. **Covington**	Markets Irish potatoes, sweet potatoes, cotton, and beans. Handles farm supply orders.

[1] Under construction in 1944.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

	Name and office location	*Nature of business*
	TANGIPAHOA PURISH	
1.	Dairy Farmers Cooperative Assn. **Kentwood**	Bargaining agency for producers selling milk in the New Orleans milkshed. Has warehouse and sells milk cans, lime, and seeds to members.
2.	La. Strawberry Selling Agency Inc — Box 352. **Hammond**	Sells strawberries at auctions. Ships vegetables mainly beans, cucumbers and green peppers.
3.	Cash Growers Cooperative Assn. **Independence**	Markets strawberries through broker who guarantees auction prices. Also sells sweet potatoes, green peppers and beans. Have their own precooling machine. Handles hampers, crates and fertilizer.
4.	The Farmers Cooperative Assn. **Independence**	Markets strawberries through auction. Also markets beans, peppers and cucumbers. Handles hampers, crates and fertilizer.
5.	Square Deal Cooperative Assn. Inc. **Independence**	Markets strawberries at auction. Precools berries. Handles hampers, crates, insecticides, and fertilizer.
6.	Ponchatoula Farm Bureau Assn. Inc. **Ponchatoula**	Markets strawberries, green beans, peppers, cucumbers, eggplant and squash. Handles seeds, fertilizers, containers and insecticides.
7.	Ponchatoula Union Coop. Assn. **Ponchatoula**	Markets strawberries, cucumbers, peppers and beans on fixed commission. Handles fertilizer containers, feeds and insecticides.
8.	Tangipahoa Pur. and Mktg. Assn. **Amite**	Markets cotton, potatoes and takes orders for fertilizer, cans, jars, pressure cookers and baby chicks.
	TENSAS PARISH	
1.	Tensas Parish Pur. and Mktg. Assn. Inc. **St. Joseph**	Markets cotton. Takes orders for seed and feed.
	TERREBONNE PARISH	
1.	Magnolia Cooperative, Inc. **Minerva**	Processes sugarcane into raw sugar and molasses and sells product.
2.	General Farmers Exchange. **Houma**	General farm supply store. Seeds, feeds, fertilizer, etc.
3.	Terrebonne Certified Easter Lily Growers Assn. **Monteguet**	Sells Easter Lily bulbs under name and brand (Organized in 1944)
4.	Houma Pur. and Mktg. Assn. Box 308 **Houma**	Takes orders for fertilizers, seeds, jars, cans and canning equipment.
5.	South La. Electric Coop. Assn. **Houma**	Builds distribution system and furnishes electric current to farms and rural establishments.
	UNION PARISH	
1.	Union Marketing Service, Inc. **Farmerville**	Markets poultry and eggs.
2.	Union Parish Pur. and Mktg. Assn. **Farmerville**	Markets sweet potatoes, Irish potatoes, melons, and tomatoes. Takes orders for feed, seed and fertilizer.
3.	Union Electric Refrigeration Coop. **Farmerville**	Freezer and locker plant.[1]

[1] Incorporated during 1944 and not ready to operate in September 1944.

Table 2, Part 2. Louisiana: List of cooperative associations — Continued

	Name and office location	*Nature of business*
	VERMILION PARISH	
1.	Vermilion Farmers Coop. Assn. Inc. **Abbeville**	Stores rice and operates general farm supply warehouse. Sells hardware, fertilizer, feed, belting, horse collars, etc.
2.	Vermilion Parish Pur. and Mktg. Assn. **Abbeville**	Handles orders for seed.
	VERNON PARISH	
1.	Vernon Parish Wool Growers Assn. **Leesville**	Operates wool marketing pool.
2.	Pitkin Farmers Marketing Assn. **Pitkin**	Markets farm produce.
	WASHINGTON PARISH	
1.	Washington Parish Pur. and Mktg. Assn. **Franklinton**	Sells feed, seed, fertilizer and salt from warehouse. Does custom feed grinding and mixes feed with molasses.
2.	Washington Parish Colored Mktg. and Pur. Assn. **Franklinton**	Handles feed, seed, sweet potato plants.
3.	Washington and St. Tammany Electric Coop. Inc. **Franklinton**	Builds distribution system and supplies electric current to farms and rural establishments.
	WEBSTER PARISH	
1.	Webster Parish Pur. and Mktg. Assn. **Minden**	Markets cotton and handles fertilizer.
	WEST CARROLL PARISH	
1.	West Carroll Mktg. Service Inc. **Oak Grove**	Markets eggs, poultry, butterfat and Irish potatoes.
2.	West Carroll Pur. and Mktg. Assn. **Oak Grove**	Markets cotton.
	WINN PARISH	
1.	Winn Parish Pur. and Mktg. Assn. **Sikes**	Markets tomatoes and potatoes.

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LOUISIANA BULLETIN NO. 393 JULY, 1945

PRIVATE FOREST LAND OWNERSHIP AND MANAGEMENT IN THE LOBLOLLY-SHORTLEAF TYPE IN SOUTHERN ARKANSAS, NORTHERN LOUISIANA AND CENTRAL MISSISSIPPI

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FOREWORD

The study herein reported was made possible by a grant from the General Education Board to the Forestry Department at Louisiana State University. The work was started early in 1942, and completed early in 1945.

Dr. A. D. Folweiler, Associate Professor of Forestry, Louisiana State University, outlined the procedure used in collecting the field data, and directed the work on the first three units. He entered the armed forces in December, 1943, and the general direction of the work on Units 4 and 5 was taken over by Prof. Ralph W. Hayes. H. J. Vaux, Associate Forester, Louisiana Agricultural Experiment Station, was field supervisor on the first two units, or until he, too, joined the armed forces. Dr. Folweiler personally supervised the field work on Unit 3, and H. H. Chamberlin on Units 4 and 5.

Acknowledgment is made to the following persons and organizations for the part they had in facilitating the work: to the Soil Conservation Service through its offices in Mansfield, Farmerville and Ruston, Louisiana, for use of aerial photographs; to the assessors of DeSoto, Sabine, Union, and Bienville Parishes, Louisiana, for use of tax rolls; to AAA offices in Philadelphia and Carthage, Mississippi, for use of aerial photographs; to the assessors in Leake and Neshoba Counties, Mississippi, for use of tax rolls; to AAA offices in Union County, Arkansas, for use of aerial photographs; to the County Agents in DeSoto, Bienville, and Union Parishes, Louisiana; Leake and Neshoba Counties, Mississippi; and Union County, Arkansas, for their general assistance.

The State Foresters of the three states where work was done, Massey Anderson in Louisiana, Albert Legett in Mississippi, and Fred Lang in Arkansas, gave us their full cooperation, particularly in selecting the areas to be worked.

INTRODUCTION

As a region, the South has approximately 44 percent of all our commercial forest land, or three times as much as any other region in the nation. Private rather than public ownership predominates.

The management of the forest lands in private ownership is one of the most important forestry problems in the United States today. The South now leads in private ownership of forest lands, and in the future is expected to be the leading timber producing region of the country.

On page 29 of the 1944 Report of the Chief of the Forest Service can be found the following statement:

> "Private forest lands will continue to constitute the area from which the bulk of the raw material for our forest industries must come. Since the productivity of these lands is so vital to national security, their management cannot be left to chance. The public interest in them can only be safeguarded if measures for public cooperation and aid are backed by appropriate regulation of cutting and related practices."

This indicates the attitude of the U. S. Forest Service toward regulation. Naturally, private industry objects to close regulation of its operations. This controversy is not without good points on both sides. Any information, from any source, which presents facts should help in the final solution. It is believed that the results of the project as reported here will be of some value.

The purpose of this investigation was to determine, on limited areas, the effect, if any, of different types and sizes of forest land ownership on cutting practice and management policies. Because of limitation of funds and time, it was necessary to confine the study to one timber type. The shortleaf-loblolly pine type was chosen because it can be managed for all kinds of forest products, and in a broad application, is probably the most widely distributed type in the Southwestern Gulf States.

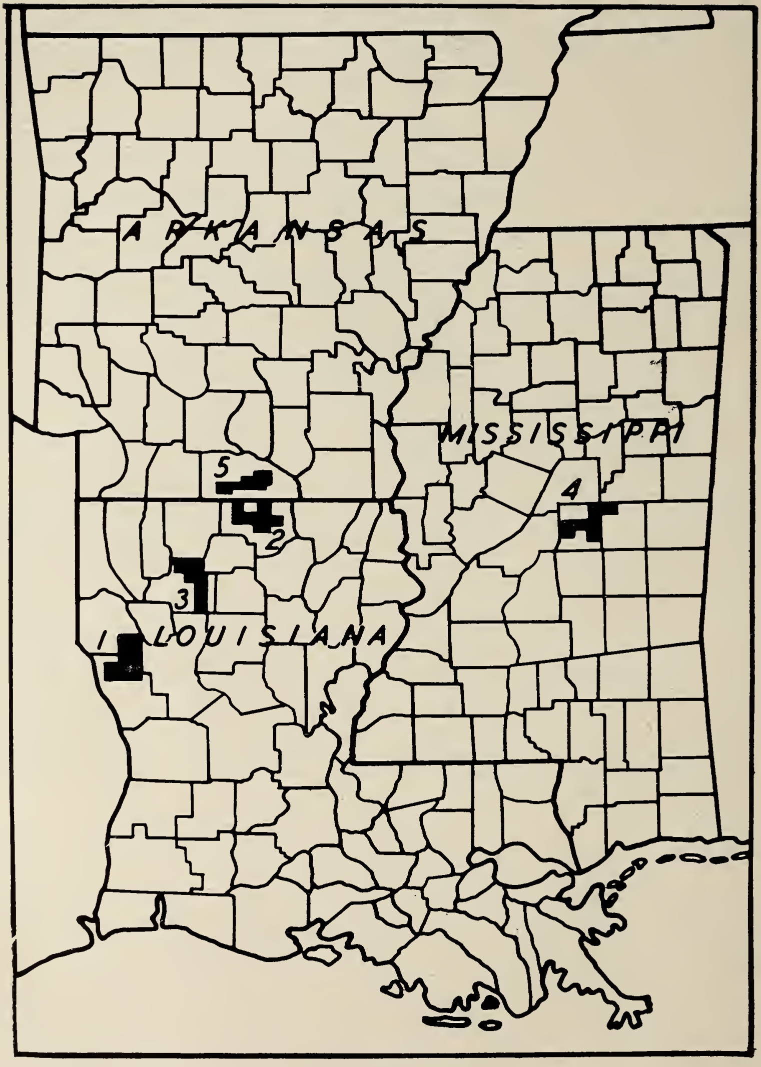

FIGURE I

The map on page 4 shows the location of the five intensively worked units. Table 1 below shows additional detail for each unit. They are all similar in character and within the desired type. Representing as near typical conditions as we were able to find in the three states, they afforded an opportunity to study the effect of several slight variables resulting from differences in each state. In these areas are some of the large old oil and gas fields of the South. Mineral resources have caused considerable speculation in subsurface values, which has, of course, had some effect on land ownership and management. Agriculture in the region is characterized by the production of cotton and corn on small farm units.

TABLE 1.

LOCATION AND ACREAGE OF SAMPLE AREAS

Sample Area No.	Gross Acreage	Forest Acreage	Percent Forested	Pine Forest Acreage Sampled	Parish County	State
1......	207,360	137,721	66	58,389	DeSoto) Sabine)	Louisiana
2......	172,800	128,040	74	68,221	Union	Louisiana
3......	161,280	109,070	68	37,763	Bienville	Louisiana
4......	178,560	128,050	72	35,900	Leake) Neshoba)	Mississippi
5......	103,680	71,001	68	23,853	Union	Arkansas
Total.....	823,680	573,882	70	224,126		

DESCRIPTION OF THE FIELD WORK

Selection of Sample Units

The project called for intensive field work on selected units in Arkansas, Louisiana, and Mississippi. Areas to be worked were determined by the "purposive selection" procedure. Purposive selection may be characterized briefly as one in which "the statistician seeks to secure a sample having the same characteristics as the universe of inquiry in respect to one or more 'control' factors."[1] For the particular purpose of the study, this means a sample in which forest growing stock is present in sufficient quantities to provide an economic asset important to the community and one in which the forest lands are controlled by individuals of varied economic and institutional character.

The criteria used for selecting the areas were: (1) a gross area of more than 100,000 acres and not more than 600,000 acres; (2) ownership of the forest land distributed among three categories of owners;

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[1] F. C. Mills, *Statistical Methods,* Henry Holt and Co., New York, 1938, Rev. Ed., p. 462.

(3) merchantable timber present in the form of pulpwood or sawlogs in sufficient quantity to form an economic asset to the community; (4) areas located within sections where wood manufacturing plants are capable of utilizing the timber; (5) the individual areas lie in not more than two minor political units, such as the county or parish, and not more than one major political unit, such as a state.

Unit Location

In order that field units would be selected which met the requirements of the above criteria, a month was devoted to an extensive field survey of parishes and counties in the shortleaf-loblolly pine type in the states of Louisiana, Mississippi, and Arkansas. Several parishes and counties were excluded immediately, either because of lack of sufficient and properly distributed pine timber or because of large public ownership.

When a number of possible units had been determined, the assessors' records in each parish or county were checked to determine the approximate number of owners and the forest acreage owned in each ownership class.

Another field survey was then made to classify the forest capital in the possible unit selected. The pine volumes were tallied on 100 to 200 quarter-acre plots in each county or parish. This information was used as a basis for determining the pine volume in each unit.

After the above information was collected and studied, the unit to be worked was definitely located by land survey divisions and on a large scale map. In each unit an effort was made to minimize the hardwood area included, and provide solid working blocks.

METHODS EMPLOYED IN OBTAINING DATA FOR STUDY UNITS

Determining Ownership Characteristics

The ownership of the forest land in the unit was one of the principal objectives of the study. The assessors' rolls for each county or parish provided a convenient means of obtaining such ownership records. In each unit the latest tax rolls were used and then brought up to date by checking with the clerk's office. In no case were the assessor's rolls over two years old. All timber land owners in each unit were classified and placed in one of the three classes described below.

Class I owners are those who own both agricultural and forest land.

Class II owners are those who own forest land only, but do not own any type of wood processing or utilization plant.

Class III owners are those who have some type of wood utilization plant in addition to the forest land owned. In most cases their ownership covered a large acreage, and they are utilizing or plan to utilize the timber grown on their land.

Selection of Sample Owners

The number of owners in the respective units ranged from 655 to 1,303, which made it impossible with the time allotted and money available, to make a detailed study of each individual land owner. Consequently, it was necessary to employ some sampling technique whereby a representative number of owners could be selected for intensive field work. The size of the sample varied with the type of ownership. One-fourth of the Class I owners, one-eighth of the Class II owners, and all of the Class III owners were selected for interview, and their lands examined.[2] In Table No. 2 are the data showing the number of owners and their acreage by units, together with the number of samples on which intensive work was done.

TABLE 2.

NUMBER OF OWNERS AND FOREST AREA BY CLASSES OF OWNERSHIP BY UNITS*

UNIT No. 1

Ownership Classification	Number of Owners		Percent in Samples	Forest Acreage		Percent in Samples
	In Unit	In Samples		In Unit	In Samples	
I.............	776	97	12.5	52,649	5,997	11.4
II.............	463	121	26.1	41,906	12,956	30.9
III.............	8	8	100	43,166	43,166	100
UNIT No. 2						
I.............	643	81	12.6	48,979	6,648	13.5
II.............	218	51	23.4	19,301	6,618	34.3
III.............	2	2	100	59,760	59,760	100
UNIT No. 3						
I.............	594	71	11.9	47,234	5,514	11.7
II.............	175	42	24.0	24,327	11,952	49.1
III.............	8	8	100	37,509	37,509	100
UNIT No. 4						
I.............	1,170	97	8.3	77,132	7,062	9.1
II.............	129	39	30.2	10,175	3,553	34.9
III.............	4	4	100	40,743	40,743	100
UNIT No. 5						
I.............	511	63	12.3	40,320	5,386	13.3
II.............	142	39	27.4	13,666	4,704	34.4
III.............	2	2	100	17,015	17,015	100
RECAPITULATION UNITS No. 1, 2, 3, 4, 5						
I.............	3,694	409	11.1	266,314	30,607	11.5
II.............	1,127	292	25.9	109,375	39,783	36.4
III.............	24	24	100	198,193	198,193	100

* Data taken from assessors' records.

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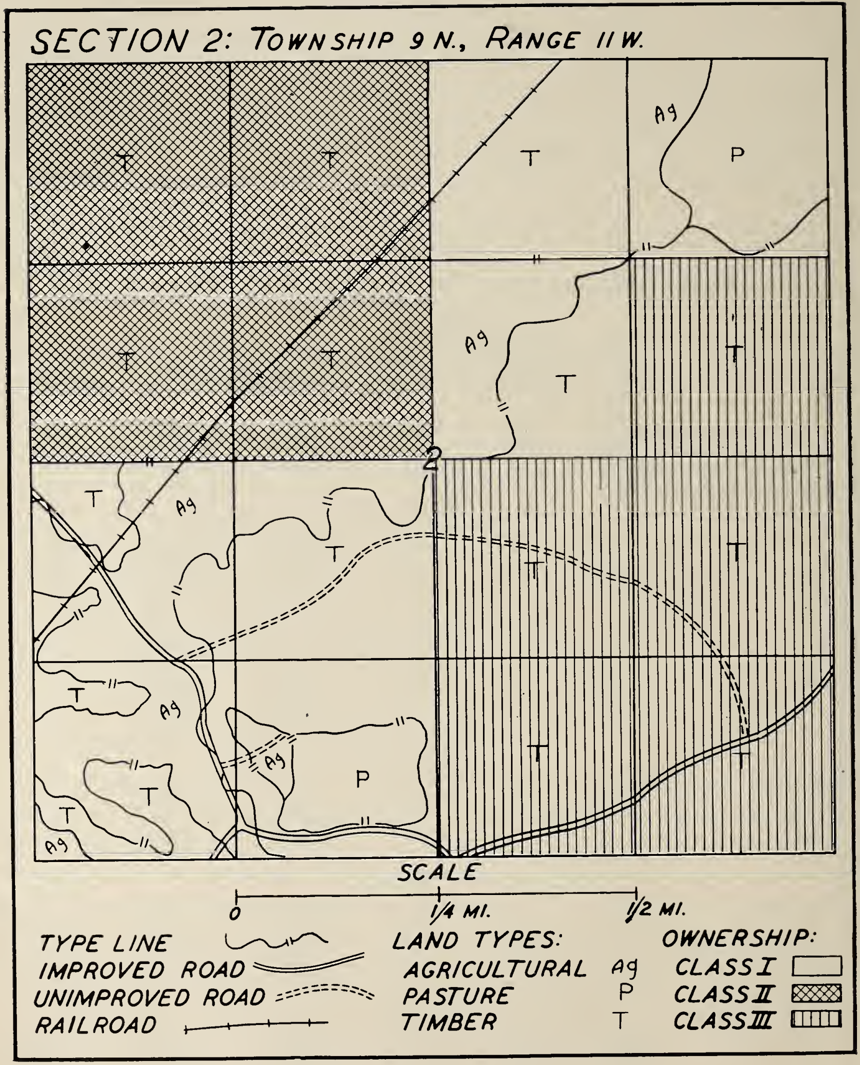
[2] Because of the difficulty of getting a representative proportion of Class I and Class II owners in the Mississippi area, every twelfth Class I name was taken as a sample owner.



SECTION 2: TOWNSHIP 9 N., RANGE 11 W.
2
T
P
Ag
SCALE
0
1/4 MI.
1/2 MI.
TYPE LINE
IMPROVED ROAD
UNIMPROVED ROAD
RAILROAD
LAND TYPES:
AGRICULTURAL Ag
PASTURE P
TIMBER T
OWNERSHIP:
CLASS I
CLASS II
CLASS III

FIGURE 2

Preparation of Type Maps

When each sample owner was selected, his legal land description was copied from the assessor's records (see Form 20—Appendix). In order to obtain correct acreage of each owner and to facilitate location of specific properties in the field, type and location maps were prepared for each area to be sampled. To distinguish between the various owners, different colors on each plat sheet represented different ownerships. The map in Fig. 2 shows a typical area, with crosshatching substituted for colors.

Interviewing Sample Owners

An attempt was made to contact and interview 624 forest land owners in the five working areas. In 516 cases, the land owner or the delegated administrator was interviewed. Where a personal contact could not be made, questionnaires were mailed to the individuals and from these, 53 replies were received. No information was obtained from 55 owners, either because of wrong address or because the owner failed to reply after receiving the questionnaire.

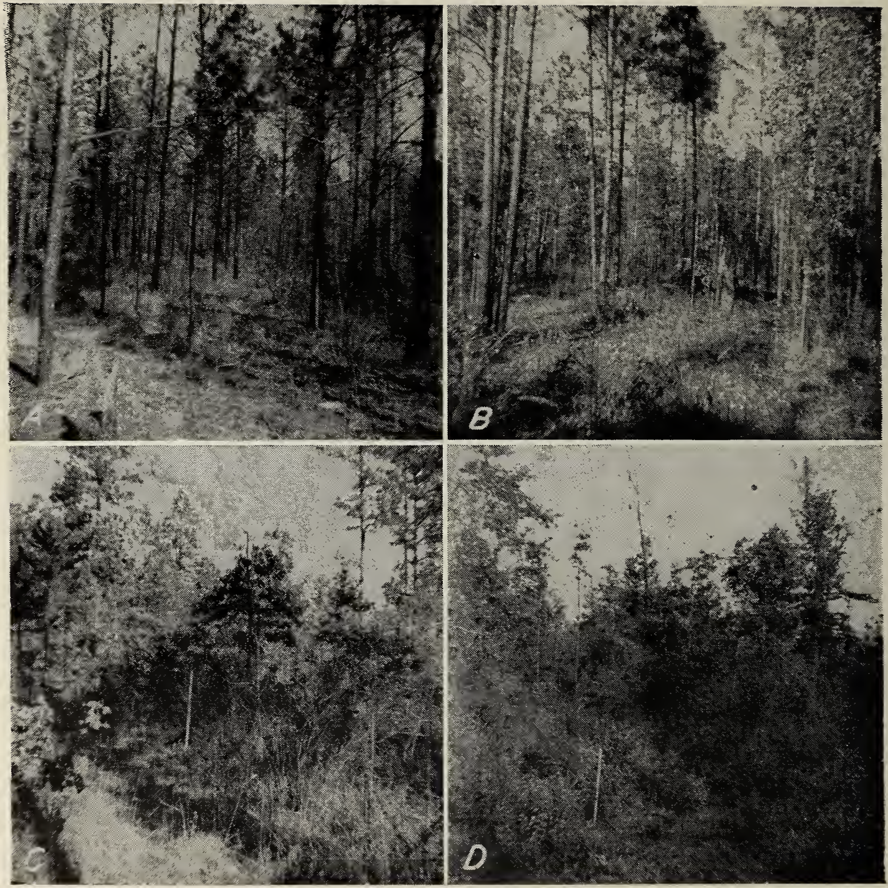
Where a personal interview was made, the interviewer stated the general purpose of the project and, through discussion, learned the attitude of the landowner with regard to his interests in his timber land. A questionnaire was filled out at the time of the interview (see Form 41—Appendix). Modified forms were used for Class III owners and those contacted by mail (see Forms 43 and 45—Appendix). Factual evidence on class of ownership, length of ownership, type of cutting, etc., was obtained at the time of the interview.

Classifying Forest Capital

In classifying forest capital of sample owners, the number of plots on each area varied with the size of the tract. In Units 1 and 2 the sampling technique was as follows: on forest tracts less than 60 acres in size, 20 percent; 61 to 640 acres, 10 percent; more than 640 acres, 2 to 5 percent. In Units 3, 4, and 5, tracts less than 60 acres in size, 10 percent; over 60 acres, 2 to 5 percent.

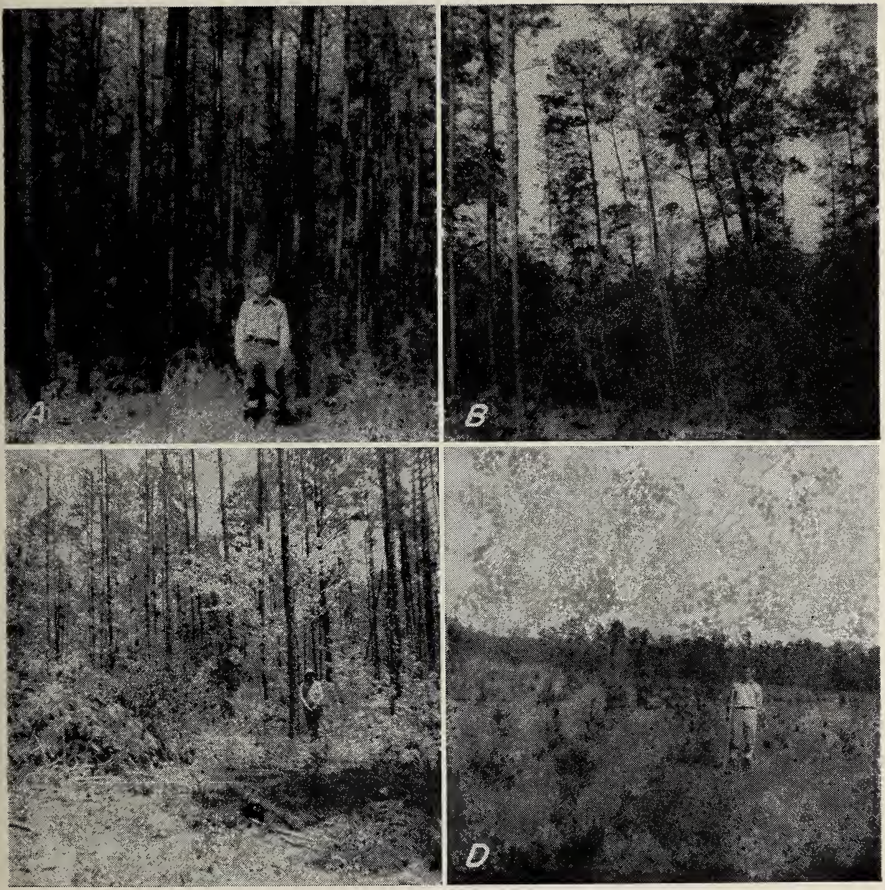
The location of the sample plots to be used in classifying each tract was governed by: (1) the percentage of sampling required, (2) the shape of the timbered area, and (3) the means of access to the tract. Plots were taken at predetermined intervals by pacing along a compass line, usually in a cardinal direction.

It is assumed that an indication of the owner's attitude toward his forest land is to be found in its relative productive condition. At the time the land was examined, the state of productivity was determined on each plot by the composition, density and size of pine timber in the stand. The classification was made by an ocular estimate of a half-acre



Forest Composition

A. Composition 4.
B. Composition 3.
C. Composition 2.
D. Composition 1.



Forest Density

A. Density 4. B. Density 3.
C. Density 2. D. Density 1.

circular plot. In classifying the plot, the observer would visualize it in four quadrants formed by two lines perpendicular to each other at its center. For example, while the observer was determining the composition of each plot, he determined by ocular estimate the percentage of pine trees present in each quadrant, rating them from 1 to 4, according to the percentage of its pine trees. The average of the four quadrants determined the composition of the plot. In classifying the density of the plot, the observer would determine whether the forest canopy covered less than one-quarter, from one-quarter to two-quarters, from two-quarters to three-quarters, or over three-quarters of the plot. Each quadrant was assigned a value of 1 to 4, based on the degree of crown cover. The average of the four determined the density. Any cutting which had been done in the last five years was recorded at the same time (see Form 60—Appendix). Pictures on page 10 show the classification of composition. Also pictures on page 11 show the classification of density and those on page 24 show classes of recent cutting.

A summary of the classification system used in this work appears in the following set of definitions.

A. *Species Composition*

1. Less than 25 percent of the trees are pines.
2. 25 percent to 50 percent of the trees are pines.
3. 50 percent to 75 percent of the trees are pines.
4. Over 75 percent of the trees are pines.

B. *Stand Density*

1. Severely depleted stands. Individual trees are isolated and scattered.
2. Sparsely stocked stands. There are either (a) many large gaps in the area occupied by trees considered, or (b) many of the trees considered are wolf trees.
3. Moderately stocked stands. There are numerous small or a few large gaps in the area occupied by trees considered, and/or a few wolf trees are present.
4. Densely stocked stands. Trees occupy all of the area; there are no wolf trees.

C. *Stand Size* (Consider only pine trees)

1. Regeneration. Pine trees less than 10 feet in height.
2. Saplings. Pine trees more than 10 feet in height but less than 5 inches d.b.h.
3. Pulpwood. Pine trees more than 5 inches d.b.h. but less than 13 inches d.b.h.
4. Sawtimber. Pine trees more than 13 inches d.b.h.

4. *Conditions of Cutting*

1. All merchantable pine removed within last 5 years. (A few pulpwood trees may be left.)
2. All pine sawlogs removed within last 5 years years. (Some or all pulpwood remains.)
3. High-grading for some forest products *without* stand improvement within last 5 years. (Some merchantable timber remains.)
4. Improvement cutting. Only part of the merchantable pine has been removed, and residual stand indicated trees were removed in such a way as to improve the productivity of the stand. Several well-formed sawlog or pulpwood trees have been left on the plot, apparently for future growth.
5. Uncut. There is no evidence that timber has been cut on the plot within the last 5 years. Stands in which an occasional tree has been removed but which have not been subject to any form of organized cutting should also be included here.

The following table shows the total number of owners and acreage in each class of ownership for the five units. This table is included to give an overall picture of the situation, and the ownership characteristics are further broken down later.

TABLE 3.

NUMBER OF OWNERS OF FOREST AREA BY CLASSES OF OWNERSHIP

Ownership	Number of Owners	Percent of Total	Total Forest Acreage	Percent of Total
Class I	3,694	76.2	266,314	46
Class II	1,127	23.3	109,375	19
Class III	24	0.5	198,193	35
TOTAL	4,845	100	573,882	100

Non-Industrial Owners

Since non-industrial owners (Classes I and II) account for 99.5 percent of all the owners and 65 percent of the total forest land, it is desirable that their ownership characteristics be further examined.

It is of some importance, therefore, to examine these groups according to the relationship of the owner's residence to property location. Forest land owners were accordingly grouped in three classes: resident, adjacent, and non-resident. Resident owners were those living on the property; adjacent owners were those who live within a twenty-five mile radius of the property; and non-resident owners were those living more than 25 miles away.

The data in Table 4 show that over half of the non-industrial owners (Classes I and II combined) live on their property which constitutes 43 per cent of the total forest land. While few in number, the non-resident owners have title to one-fifth of the land. Eighty percent of the land is owned by people who live either on the land or only a short distance from it.

TABLE 4.

RESIDENCE OF NON-INDUSTRIAL FOREST LAND OWNERS AND ITS RELATION TO PSI

Tenure Group	Total Number Owners	Per-cent	Total Forest Acres Owned	Per-cent	Number Owners Sampled	Per-cent	Pine Forest Acres	Per-cent	PSI*
Class I									
Resident	2,458	67	153,299	57	257	62	13,258	47	3.6
Adjacent	976	26	89,822	34	107	26	8,339	30	3.7
Non-resident..	260	7	23,193	9	48	12	6,556	23	3.4
Total	3,694	100	266,314	100	412	100	28,153	100	3.6
Class II									
Resident	176	15	10,420	9	14	6	879	4	2.6
Adjacent	560	50	49,055	45	101	48	10,084	53	3.4
Non-resident..	391	35	49,900	46	97	46	8,164	43	3.2
Total	1,127	100	109,375	100	212	100	19,127	100	3.2
Class I & Class II									
Resident	2,634	55	163,719	43	271	44	14,137	30	3.5
Adjacent	1,536	32	138,877	37	208	33	18,423	39	3.5
Non-resident..	651	13	73,093	20	145	23	14,720	31	3.3
Total	4,821	100	375,689	100	624	100	47,280	100	3.5

*P.S.I. is explained on page 25.

Legal Identity

The classifications listed in Table 4 were further broken down, according to the nature of ownership, into individual owners, joint owners and corporate owners. Some forest properties are owned by individuals, others are controlled by joint owners, either in the form of a partnership or estate; and a third group is composed of corporate owners. The data in Table 5 show that individual owners are by far the most numerous, comprising more than four-fifths of the total, and owning slightly more than three-fourths of the land.

OWNERSHIP AND MANAGEMENT SITUATION IN THE WORKING UNITS

Size of Timber by Ownership Classes

The competition of markets appears to have a definite influence on the size of timber in each ownership class. The industrial owners either process timber from their own lands, or buy from lands of non-industrial

TABLE 5

LEGAL CHARACTER OF NON-INDUSTRIAL OWNERS AND THE RELATION TO PSI

Character of Ownership	Total Number Owners	Per-cent	Total Forest Acres Owned	Per-cent	Number Owners Sampled	Per-cent	Pine Forest Acres Owned	Per-cent	PSI*
Individual Owners									
Male	3,319	69	240,841	64	400	64	25,344	54	3.4
Female	742	15	43,952	12	91	15	5,747	12	3.8
Sub-Total	4,061	84	284,793	76	491	79	31,091	66	3.5
Joint Owners									
Estates	524	11	47,831	13	67	11	5,400	11	3.6
Partnerships..	166	3	15,500	4	53	8	4,046	9	3.5
Sub-Total	690	14	63,331	17	120	19	9,446	20	3.5
Corporate									
Owners......	70	2	27,565	7	13	2	6,730	14	4.1
Total	4,821	100	375,689	100	624	100	47,267	100	3.5

*P.S.I. is explained on page 25.

owners in order to conserve the forest capital on their own lands. In adopting this practice they are postponing the time when they will have to depend largely upon their own lands for their timber requirements. It is a general belief among sawmill operators that the sawlog timber on non-industrial lands is badly depleted. The validity of this statement finds support in the following table.

TABLE 6.

SIZE OF PINE TIMBER ON INDUSTRIAL AND NON-INDUSTRIAL LANDS

	Percent of Acres				
Ownership Class	Seedlings	Saplings	Poles 5-12" d.b.h.	Sawlog trees over 13" d.b.h.	Total
1 and II...........	8	29	54	9	100
III.............	4	18	51	27	100

The data in Table 6 were determined by the predominant number of trees in the size classification found on each sample plot. It is evident that the industrial lands are supporting three times as much sawlog timber as the non-industrial lands by pine acreage. Also these data confirm the statement, made previously, that industrial owners are conserving the timber on their own lands. Timber of pulpwood size is approximately the same in percentage value on industrial and non-industrial lands.

Fire and Reproduction

A. and B. Fire kept out. Both sites are reproducing to pine.
C. and D. Sites burned. All pine seedlings killed.

Attitude Toward Forest Fires

With the exception of the Mississippi Unit, all the units are within the fire protection districts of their respective states. Due to lack of local interest, timber land owners in the sample Mississippi Counties are not receiving state aid for fire protection. There was a noticeable variation among the working units as to the number of uncontrolled fires and the extent of burning. Field examination showed that the Arkansas Unit suffered less from uncontrolled fires than any other. However, the interviews with the Arkansas owners revealed that only two non-industrial sample owners were cooperating with the Arkansas State Forestry Commission by having their lands in fee under a cooperative agreement for fire protection. It was quite evident from observations made in the field that the Mississippi unit suffered the greatest amount of damage from uncontrolled fires.

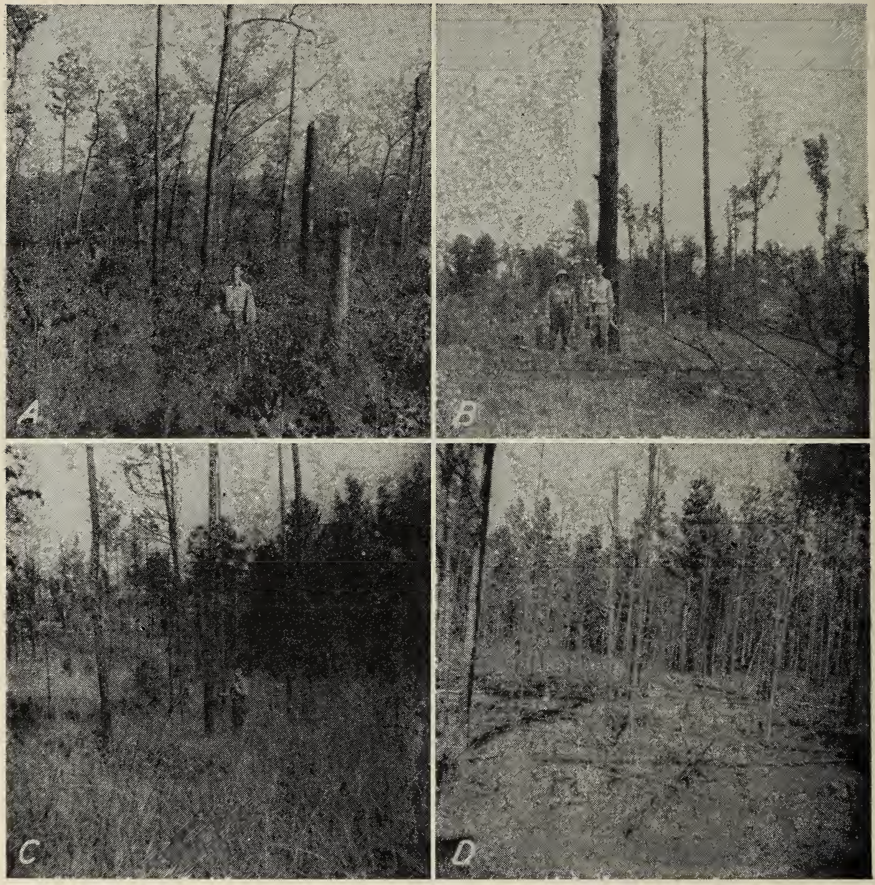
The only sample owners who were cooperating to any extent with the state forestry departments by paying fees for fire protection are the industrial or Class III owners. In the working units within fire protection districts, over 98 percent of the industrial lands were under cooperative agreements for fire protection with state forestry organizations. The percentage of non-industrial land that was under cooperative agreement with the state forestry departments was negligible. In the five selected units, only two Class I and five Class II owners indicated interest in fire protection by having their land under cooperative agreement with the state forestry departments.

An attempt was made at the time of the interview to discover why the non-industrial owners were taking a negative attitude toward fire protection. Their reasons fall into one of the three following categories: first, these owners feel that they do not own enough forest land or produce enough timber to warrant placing their lands under cooperative agreements with the state forestry departments; second, those adjacent to, or interspersed with, industrial lands know that they will receive some protection gratis under an efficient fire protection system; and, third, they have not yet been educated to the necessity for protection.

Many owners realize the importance of keeping uncontrolled fires off their lands, and make a personal effort to protect their forest land and suppress the fires that occur. Resident owners are prepared to do this because they are constantly accessible. Adjacent and nonresident owners, on the other hand, are not in a position to suppress fires that might occur on their lands because they are not there when the fire occurs. They often do not know a fire has occurred until some time later.

Effects of Uncontrolled Fires

A forest may not be reproduced except through seedlings. All young pine trees are highly susceptible to injury or death from contact with fire. Even light annual burning will eventually kill most seedlings.



Fire Kill of Larger Pine Trees

Hot fires ran through slash of all four sites after logging.

A. Seed trees killed—now reduced to snags.

B. Seed trees killed.

C. and D. Seed trees and most of residual growing stock killed.

Periodic burnings of up to eight or ten years in thick stands of reproduction and saplings kill all or most of the trees, and seriously injure those left, thus defeating the purpose of seed trees.

Merchantable sized pine trees also, are killed or injured by uncontrolled fires. This is especially true where stand improvement cuttings have been made. Slash allowed to burn around seed trees or the residual stands from selective cuttings kills most of the trees regardless of size. Such periodic burning tends to discourage the non-industrial owners with stand improvement cutting, and encourage clear cutting. A number of sample owners on the units had cut their timber under stand improvement methods but subsequent fires had practically wiped out the residual stand.

Relation of Timber Markets and Timber Sales to Forest Management

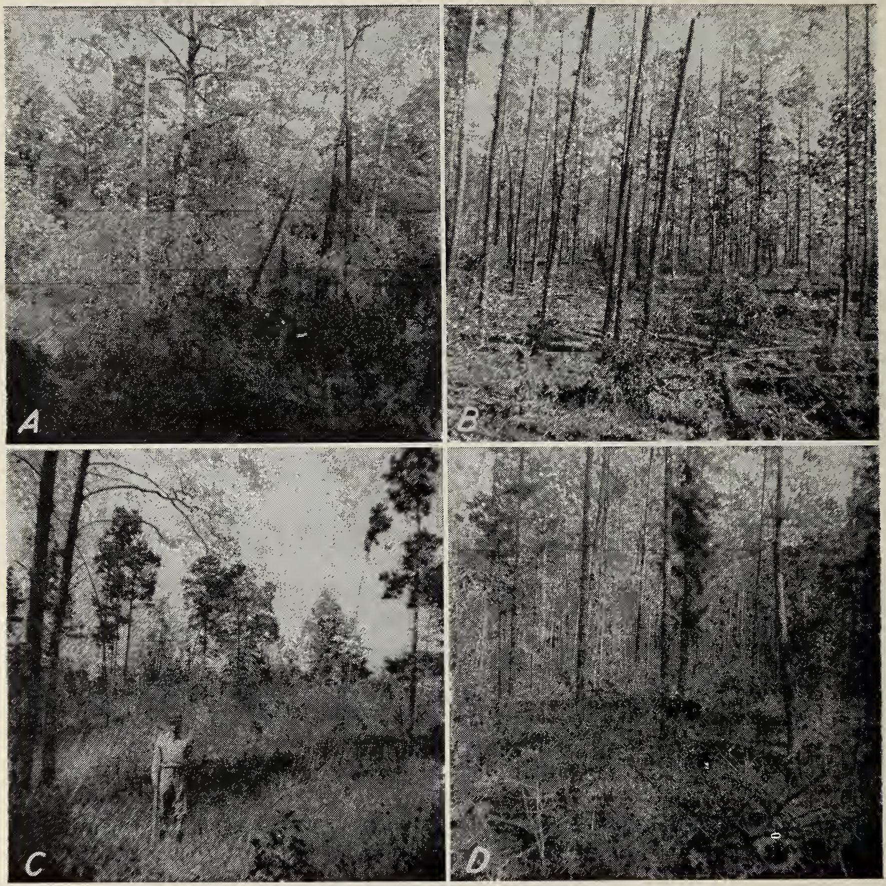
In all the working units, timber markets were very active during the last five years. This keen competition had a definite effect on the type of forest management practiced on non-industrial lands. Because of this keen competition, the question of whether the owner or buyer promoted the sale was investigated. From data gathered, the buyer urged the owner to sell in 70 percent of the sales. This high percentage tends to indicate the scarcity of timber in the units studied.

Highly competitive markets made it impossible for some of the industrial owners to convince other forest land owners of more desirable cutting practices. Some of the industrial owners had cut timber under a conservative system on non-industrial lands, only to have the owner sell the residual stand of pulpwood to someone else. Over 55 percent of the non-industrial owners sold their timber on a lump sum bases. They were primarily interested in getting the maximum current income at the time of the sale. The consensus of opinion among non-industrial owners when ready to market their timber, was that they would be "skinned," so at the time of cutting they preferred to take one big skinning and be finished with it. Because of this prevalent opinion, relatively few owners were taking any interest in periodic cutting.

While a number of owners sold their timber on a unit basis, they had no means of checking the amount of timber taken from their lands. They appeared content, accepting whatever scale the buyer credited to them. In 78 percent of the sales the timber was cut below ten inches diameter at stump height.

Reasons for Owners' Negative Attitude

At the time of interview, information was sought on ownership attitudes unfavorable to forest management. The various reasons why owners are uninterested in their forest lands are shown in Table 7. The



Cuttings to Diameter Limits

A. and B. Pine cut to 6″ butt diameter.

C. and D. Pine cut to 10″ butt diameter.

two reasons advanced most frequently for a negative attitude were incompetence to carry on forest practices and inability to spare the time required. In over one-fifth of the cases, no attempt was made to improve the forest land because of sheer lack of interest. Only 3 percent of the owners felt that the cost was too great in relation to the return from forest products.

TABLE 7.

NEGATIVE OWNER ATTITUDES

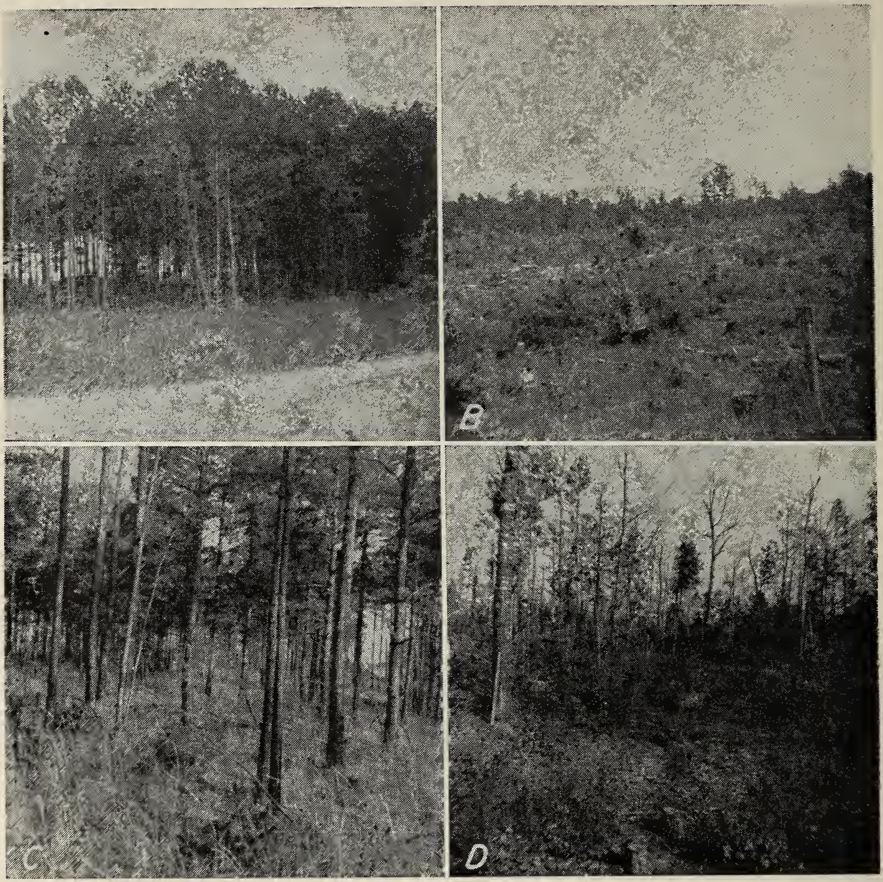
Reasons for Negative Attitudes	Class I		Class II		Total	
	Number Owners	Percent	Number Owners	Percent	Number Owners	Percent
Not competent to conduct forestry practices	127	38	48	31	175	36
Unable to spare time	118	36	50	33	168	35
Not interested in forest land	64	19	38	25	102	21
Believe woods need no care	15	5	11	7	26	5
Trespass, fires, or other costs too high	6	2	6	4	12	3
Total	330	100	153	100	483	100

It is impossible to point to any one particular factor which contributed to the negative attitude held by most of the non-industrial owners toward improving management on their forest lands. More than two-thirds of them are classified in the agricultural group, and have always realized income from their farm crops annually. As a result, they are reluctant to adopt measures for improving their timber stands which involve waiting a number of years between harvesting timber crops. In general, non-industrial owners use their timber as a bank account, and in emergencies cut and sell regardless of the condition of the stand or the stumpage value. In 76 of the 328 instances where timber was sold, it was because the owner was badly in need of funds.

With the exception of the Mississippi unit, the investigations were made within some of the oldest oil and gas fields in the South. Speculation is constantly going on in these areas and has had some affect on forest values and management. Many owners of forest land are interested in speculative values, because they believe mineral deposits might eventually be discovered there. To this group, forestry has very little appeal. Evidence collected shows that over 9 percent of the non-industrial owners are holding their land primarily for speculative purposes.

Cutting Practices on Industrial and Non-Industrial Lands

At the time the land was examined, observaitons were made of any cutting practices carried on during the previous five years. The data in Table 8 show that 73 percent of the industrial lands had not been cut,



Contrasts of Cutting Practices

A. and B. Adjacent sites of formerly identical stands. *A.* is being selectively cut for pulpwood. B. was clear-cut for pulpwood. Hardwood brush taking possession of the site.

C. Improvement cutting was made for sawlogs and pulpwood, leaving good trees to grow.

D. All merchantable trees were cut, leaving poor quality trees to grow.

in contrast to 55 percent for the non-industrial. Another impressive fact is that 43 percent of the industrial land was cut under stand improvement methods in contrast to 9 percent for non-industrial land. These data not only indicate that forest capital is being conserved on industrial lands, but that these lands have a valuable seed source for restocking the areas cut.

TABLE 8

OWNERSHIP OF PINE FOREST LAND BY CHARACTER OF CUTTING

Character of Cutting	All Land		Cut Land in Last 5 Years	
	Industrial	Non-industrial	Industrial	Non-industrial
All merchantable timber removed......	3	15	13	32
All sawlogs (13" dbh and over) removed ...	7	17	25	39
Partial cutting for special products	5	9	19	20
Stand improvement cutting	12	4	43	9
Uncut within last 5 years	73	55	..	..
	100	100	100	100

In addition, it was noted on the ground that an appreciable amount of normally pine lands are reverting to low grade hardwood stands. This was usually so in the case of mixed pine-hardwood stands supporting pines of merchantable size only. The pines were clearcut, releasing the hardwoods to grow, reproduce, and take possession of the site.

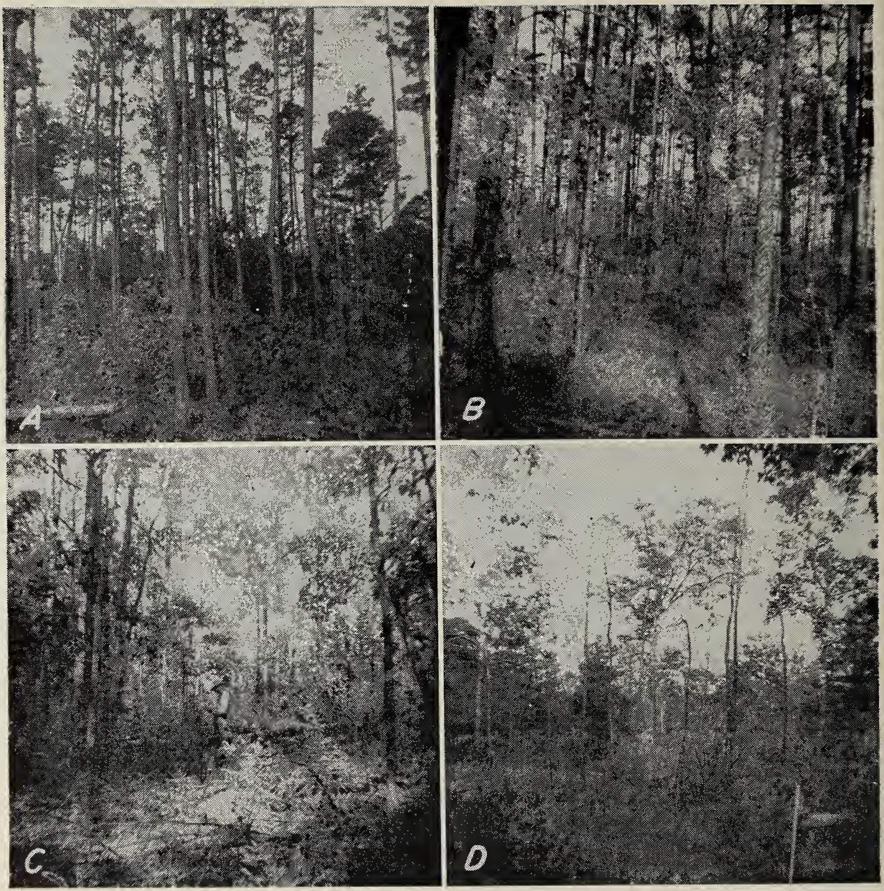
Large hardwood trees of the wolf type, unmerchantable because of too much rot, were left standing because they were at the time uneconomical to fell. These trees could have been girdled in a few minutes, each, but the land owner or operator had not learned the value of this.

Stands of merchantable even-aged pine trees supported a suppressed understory of hardwoods. Either selective or clearcutting in the pines released some or all of the hardwoods to largely take possession of the sites.

THE ATTITUDE OF OWNERS TOWARD THEIR PROPERTY

Methods of Measuring Attitude

The attitude which an owner takes toward his forest property may be determined either by interviewing him and getting his ideas on the subject in question, or by actually checking on what he is doing through field examination. In an interview, a person might give misleading answers to questions and, therefore, conceal his true attitude relative to the information sought. In spite of this condition, much evidence was collected in this way which reflected the owner's attitude. Because of



Classes of Cutting

A. Stand improvement cutting (No. 4).

B. High-grading for forest products without stand improvement. Some merchantable timber remains (No. 3).

C. All sawlogs removed. Pulpwood trees remain (No. 2).

D. All merchantable pine trees cut (No. 1).

the wide variation in ownership attitudes, the interviewer's judgment at the time of the interview may be valuable. Since sufficient authentic information concerning his management practices could not be determined from an interview, field examination of his forest land was resorted to in determining its condition.

Measuring Pine Productivity

Another objective of the study was to measure pine stocking on each sample area. Consequently, a technique was devised for its determination on each plot without measuring the individual trees. This was expressed in terms of pine stocking index. It indicates the extent to which the forest area is occupied by pine trees without regard to size class. The pine stocking index will be referred to as the PSI wherever used in this report.

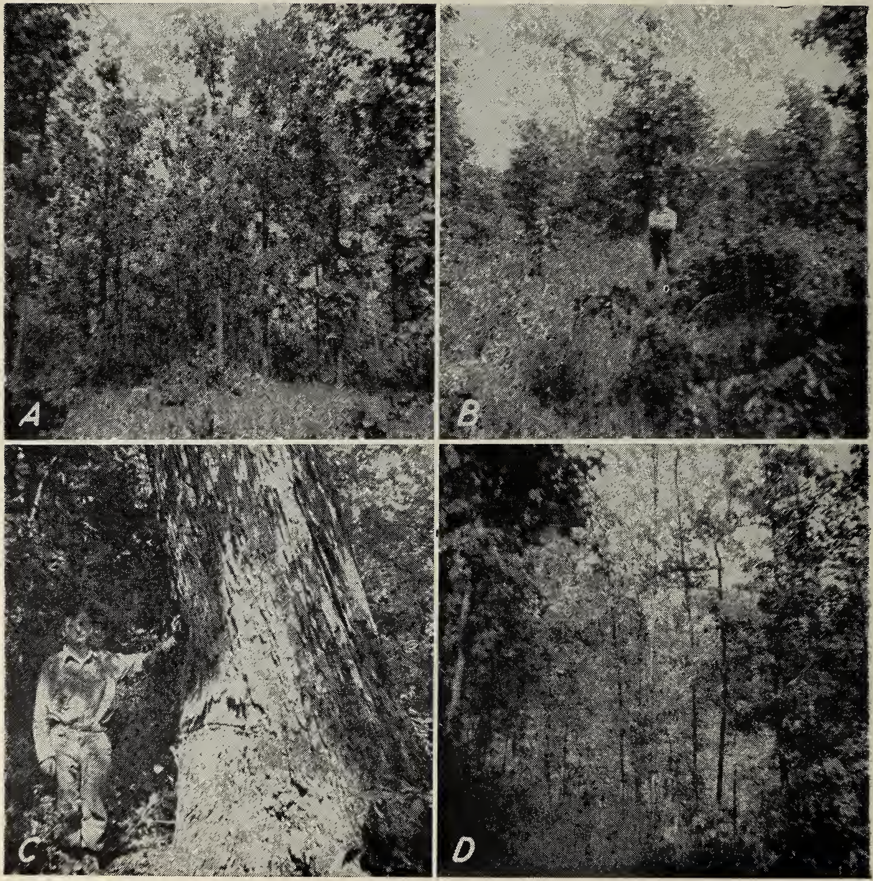
In computing the PSI on each plot, the two variables recorded were composition and density. By composition is meant the percentage of forest cover composed of pine growing stock on each plot. Density is defined as the degree to which the plot is covered by forest vegetation, regardless of species. The effect of these factors shows the extent to which the site is utilized by pine growing stock. Index numbers showing the PSI as determined for each plot by the indicated composition and density are shown in Table 9. All plots on each sample tract are averaged to give the PSI for that tract or for that sample owner.

TABLE 9.

TABLE FOR DERIVING THE PSI

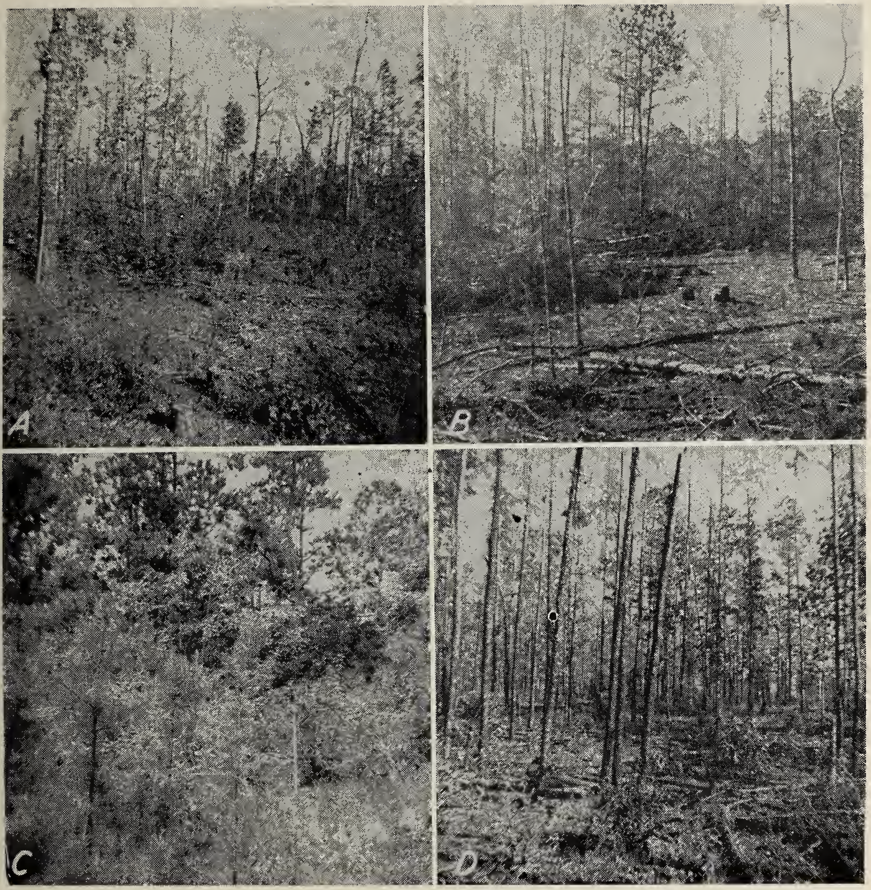
Composition	Density	PSI
4	4	10
4	3	9
4	2	5
4	1	1
3	4	7
3	3	6
3	2	4
3	1	1
2	4	4
2	3	4
2	2	2
2	1	1
1	4	1
1	3	1
1	2	1
1	1	0

These index numbers were based on classification definitions on page 12. As a check on the validity of this method, measurements were taken and computed on 52 basal area plots distributed throughout the units which showed that pine stocking was almost identical with PSI based on the classification definitions.



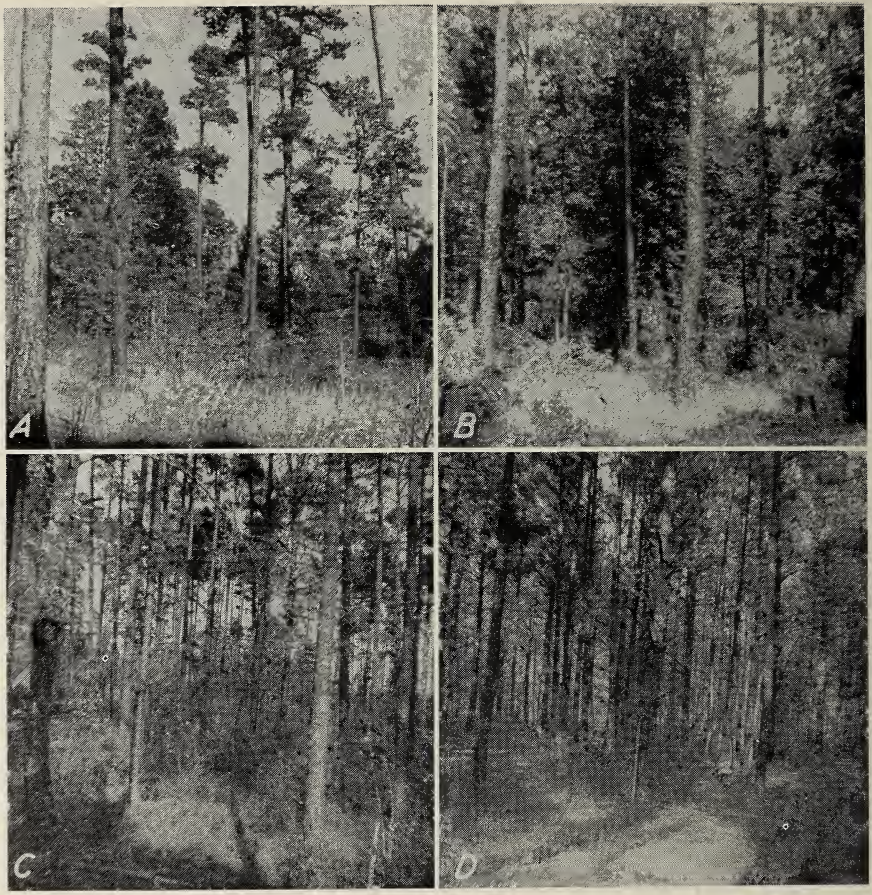
Residual Hardwoods on Pine Lands

All pines cut to 6″ minimum diameter. Uncontrolled hardwood trees taking possession of the pine sites.



ILLUSTRATING PSI

A. PSI 0.
B. PSI 1.
C. PSI 2.
D. PSI 4.



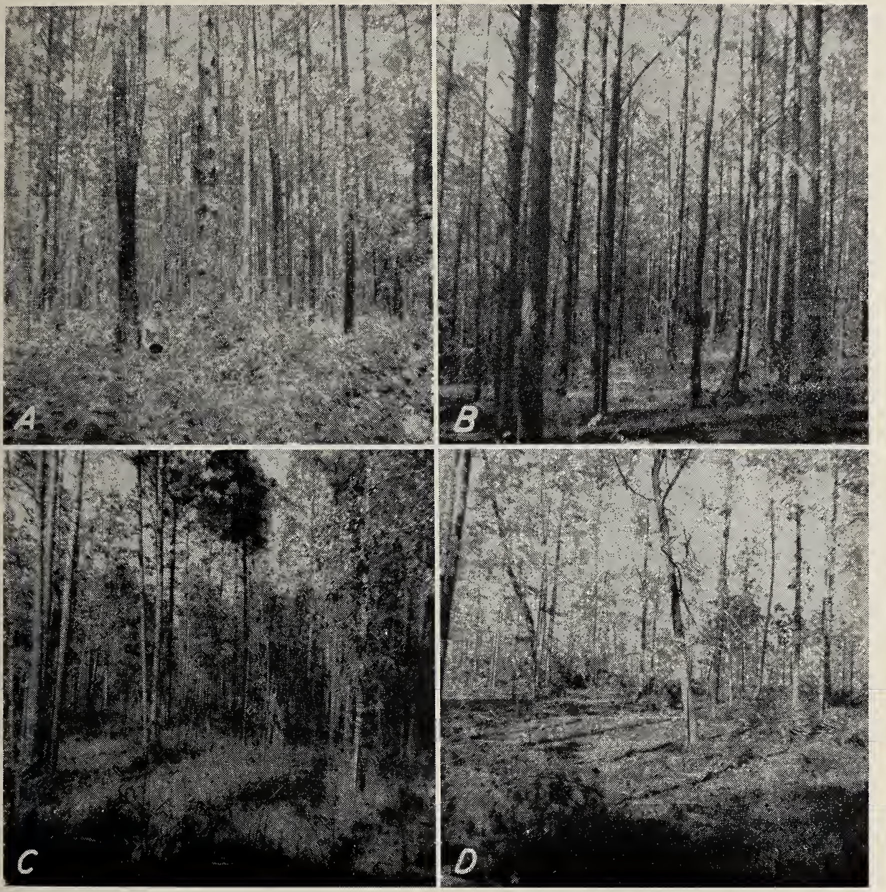
Illustrating PSI

A. PSI 5.

B. PSI 6.

C. PSI 7.

D. PSI 9.



Illustrating PSI

A. PSI 10.

B. PSI 9.

C. PSI 6.

D. PSI 1.

Numbers of Owners and PSI

Table 10 shows the distribution of ownerships among the pine stocking indices. The lands of over four-fifths of the owners are producing pine timber at less than half of their capacity. The lands of two-thirds of the owners are producing at only one-third of their capacity.

MANAGEMENT IN RELATION TO VARIOUS FACTORS WHICH DIFFERENTIATE OWNERSHIP

In the previous portion of this report the discussions have been concerned with the type of ownership and management of the forest land and the attitudes of the owners. The remaining portion will be devoted to these and other factors considered in the study as measured quantitatively by means of the pine stocking index.

Factors Affecting Management on Industrially Owned Forest Lands

Of the twenty-three industrial owners of forest land in the five working units, nine were classified as small owners and fourteen as large owners. All those with a rated annual capacity of over 8 million board feet were classified as large owners. As a whole, the sample forest areas are in good productive condition.

Of the twenty-three industrial owners mentioned above, with an aggregate of 176,846 acres of pine forest land, three were pulpwood operators and twenty were sawmill operators. The nine small operators held title to an aggregate of 2,185 acres. Lack of capital, and lack of interest in continuous operation, are indicated by the small amount of forest land owned by small operators. Additional evidence that the small operator is not interested in forest management is reflected by the pine stocking index of his land. The weighted PSI for the small operator was 3.1 while for the large operator it was 4.9.

The management practices on the sampled areas varied from "very extensive" on the lands held by small industrial owners to "very intensive" on the large industrial holdings. Most of the large operators are showing a definite interest in their forest lands by building up the forest capital on them. Timber cutting over most of the large holdings has been rather conservative. However, there was no indication that the small operators were attempting to increase their forest capital. None of the nine small operators control enough forest land to maintain a permanent source of raw material for their plants and, to continue in operation, they will have to depend on the non-industrial owners for future raw materials.

TABLE 10.
NUMBER AND PERCENT OF OWNERS BY PRODUCTIVITY CLASSES (PSI)

Average PSI	UNIT 1. LOUISIANA Number of Sample Owners	UNIT 1. LOUISIANA Percent of Total	UNIT 2. LOUISIANA Number of Sample Owners	UNIT 2. LOUISIANA Percent of Total	UNIT 3. LOUISIANA Number of Sample Owners	UNIT 3. LOUISIANA Percent of Total	TOTAL - LOUISIANA Number of Sample Owners	TOTAL - LOUISIANA Percent of Total
0.1 - 1.0......	8	4.2	0	0	3	2.7	11	2.7
1.1 - 2.0......	28	14.6	7	6.7	20	17.8	55	13.5
2.1 - 3.0......	39	20.3	22	21.2	29	25.9	90	22.0
3.1 - 4.0......	44	22.9	23	22.1	22	19.6	89	21.8
4.1 - 5.0......	40	20.8	14	13.5	21	18.8	75	18.4
5.1 - 6.0......	21	10.9	19	18.3	11	9.8	51	12.5
6.1 - 7.0......	9	4.7	7	6.7	3	2.7	19	4.7
7.1 - 8.0......	3	1.6	6	5.8	1	0.9	10	2.5
8.1 - 9.0......	0	0	5	4.8	2	1.8	7	1.7
9.1 - 10.0......	0	0	1	.9	0	0	1	.2
Total....	192	100.0	104	100.0	112	100.0	408	100.0

Average PSI	UNIT 4. MISSISSIPPI Number of Sample Owners	UNIT 4. MISSISSIPPI Percent of Total	UNIT 5. ARKANSAS Number of Sample Owners	UNIT 5. ARKANSAS Percent of Total	TOTAL OF ALL UNITS Number of Sample Owners	TOTAL OF ALL UNITS Percent of Total
0.1 - 1.0......	17	12.6	11	10.6	39	6.0
1.1 - 2.0......	38	28.1	27	26.0	120	18.5
2.1 - 3.0......	23	17.0	20	19.2	133	20.6
3.1 - 4.0......	17	12.6	16	15.4	122	18.9
4.1 - 5.0......	17	12.6	16	15.4	108	16.7
5.1 - 6.0......	9	6.7	6	5.8	66	10.2
6.1 - 7.0......	11	8.2	5	4.8	35	5.4
7.1 - 8.0......	2	1.5	2	1.9	14	2.2
8.1 - 9.0......	1	0.7	1	0.9	9	1.4
9.1 - 10.0......	0	0.0	0	0.0	1	0.1
Total....	135	100.0	104	100.0	647	100.0

Type of Cutting on Industrial Lands

The type of cutting that is being applied to industrial lands further reflects the attitude of the owner. During the five years preceeding the field examination, the large operators cut only 26 percent of their pine timber land while the small operators cut 62 percent. On the lands that were cut only 2 percent of the land of the small operator was cut under stand improvement. On 88 percent of the land cut by them, all the sawlogs and merchantable timber had been removed. These facts reflect the lack of interest shown by the small operators in increasing the forest capital on their lands. Table 11 below shows these facts.

TABLE 11.

MANNER IN WHICH CUTTINGS WERE MADE ON THE LANDS OF INDUSTRIAL OWNERS WITH RELATED PSI

Type of Class III Owner	Stand Improvement	Partial Cut	All Sawlogs Removed	All Merchantable Material Removed	Pine Forest Acres Cut	(Weighted) PSI
Large	45	20	25	10	45,903	4.9
Small	2	10	33	55	1,359	3.1

The difference in PSI, by states, on the units worked, is shown in the following table. The low PSI for Mississippi's Class III owners can be partly explained by the fact that there were only three industrial owners in the unit, and two of them owned very little land, and were not doing a good cutting job.

TABLE 12.

COMPARATIVE WEIGHTED PSI BY STATES

Ownership Class	Louisiana	Mississippi	Arkansas
I	4.0	2.9	3.4
II	3.9	5.4	2.7
I & II.........	4.0	3.3	3.1
III	5.3	3.2	5.1

FACTORS AFFECTING FOREST MANAGEMENT ON NON-INDUSTRIAL LANDS

Factors affecting forest management on non-industrial lands may or may not be correlated with ownership classification. To obtain some evidence of the relationship between ownership class and the type of management, the data on forest productivity were classified under different categories and analyzed to determine the significant differences.

Residence and PSI

The amount of time devoted to supervision of forest land is determined to some degree by the distance an owner lives from his forest property. Resident and adjacent owners have an advantage over non-resident owners in supervision, as indicated by Table 4. It may be noted from this table that in Class I the non-resident owners have a lower PSI than the other two groups. Different types of residence had no appreciable effect on pine productivity.

Legal Identity and PSI

One characteristic chosen for determining the relationship between management and productivity was the legal identity of the land owner. The data presented in Table 5 show that the individual male owners are by far the most numerous but their lands have the lowest PSI classification. There is a marked contrast in productivity of land owned by the male group of individuals and of the non-industrial corporate owners. The joint ownership groups have the same PSI as the mean for the non-industrial corporate owners.

Length of Ownership and PSI

Length of ownership has always been cited as one of the determinants of interest in forest land. The data in Table 13 show that there is very little correlation between length of ownership and the productivity of the land. Although differences are small, the productivity index increases as the length of ownership increases. The differences, however, are not great enough to assume that the management of forest lands under stable ownership are greatly superior to those under short time ownership.

TABLE 13

RELATION OF LONGEVITY OF OWNERSHIP TO PSI

Title Acquired	PSI	Number of Owners
Before 1913	3.7	112
1913 to 1931	3.5	243
1931 to 1942	3.4	205

Size of Holding and PSI

Another factor which has been considered of importance in influencing forest practice is the distribution of ownership according to the size of holding. The size of holding and distribution of non-industrial owners is shown in Table 14. Most of the owners interviewed were of the opinion that they did not own enough forest land to carry on forest practices. To them the incentive to adopt forest management practices is limited to owners who have large tracts of timber. The data in Table

14 show that the difference in productivity between small and large land owners is comparatively small. This seems to disprove the validity of the previous statement. The small land owners, those with less than 75 acres, amount to 74 percent of all the ownerships studied in the survey, but control only one-third of the forest land. Of considerable significance is the fact that 40 percent of the forest land is in holdings of over 200 acres, and is held by only 6 percent of the owners. The size of forest holding does not appear to have significant relationship to forest practice on the land, as indicated by PSI in Table 14.

Table 14.

Relation of Size of Holding to PSI

Size of Holding (acres)	Number of Owners	Area	PSI
8-25	29	7	3.2
26-50	31	14	3.5
51-75	14	11	4.0
76-100	9	9	3.7
101-125	4	6	4.6
126-150	3	5	4.1
151-175	2	4	3.3
176-200	2	4	4.7
Over 200	6	40	4.3
Total	100	100	...

Ownership Objective and PSI

The primary purpose or objective of a land owner in holding forest property is of importance in relation to the productivity of the land. In order to determine the objective of ownership or land use, each person interviewed was classified according to the categories listed in Table 15. The table indicates that farm owners interested in the growing of timber in conjunction with farming, have a higher PSI than

Table 15.

Relation of Objective to PSI (Non-Industrial Ownership)

Ownership Objective	Number of Owners	Pine Forest Acres	PSI
Farming by owner	196	8,288	3.3
Farming by tenant	56	3,859	3.1
Explored subsurface values	9	2,349	4.0
Existing timber values	55	4,957	2.8
Timber growing values	100	10,604	3.8
Speculative values	44	5,791	3.0
Grazing	7	241	3.3
Other values	9	444	3.2
Timber growing and farming by owner	77	4,850	4.2
Timber growing and farming by tenant	17	1,205	4.5

any other group of owners. Owners who said that their primary interest in owning land was for the *existing* timber actually had the lowest PSI. They probably meant that their interest in such timber was to get all they could out of what they have now, and were not interested in the future. The object of ownership appears to have some relation to the PSI found on the areas studied, but this factor is less important than others.

Occupation and PSI

The occupation of an owner might be of importance in determining his attitude toward management of his forest land. During the field work, information on the owner's occupation was collected. The owners were grouped according to their occupations, and PSI ratings as shown in Table 16. The professional group includes teachers, lawers, physicians, preachers and pharmacists; the business class is composed of salesmen, bankers and filling station operators; the agricultural class includes all those associated with farming; wage earners include all those who work by the day, week, or by piece work; domestics are housewives; inactives are men and women who have retired. On examination of the data in this table, one may see at once that there is little correlation between PSI and occupational group. However, forest lands owned by the professional group had the highest PSI, while those owned by the inactive group had the lowest. The PSI for all other occupational groups varied only slightly.

TABLE 16.

OCCUPATION RELATED TO PRODUCTIVITY OF NON-INDUSTRIAL FOREST LAND

Occupation	Number in Sample	Percent	Area of Pine Land	Percent	PSI
Professional	36	7	2,164	5	3.7
Business	82	15	14,042	32	3.5
Agriculture	235	43	12,662	29	3.5
Wage Earners	76	14	5,411	12	
Domestics	70	13	5,344	12	
Inactives	42	8	4,546	10	3.4
Total..............	541	100	44,169	100	3.4

The previous pages have reported the facts from the study. It is not our purpose to go into detailed discussion of these facts, or make recommendations from them. The important things are self-evident, and where conditions should be changed anyone really interested can see what changes would help the situation. It is felt, however, that the following brief summarization of facts and more or less self-evident conclusions will clarify the story.

SUMMARY AND CONCLUSIONS

The statements here are, of necessity, based on the findings on the five units studied. It should not be assumed that they would apply exactly to any other unit area that might be set up in the loblolly-shortleaf type in the Southwestern Gulf region, but it is believed that they indicate the average condition to be found.

The investigation was undertaken with the main purpose of studying ownership characteristics in relation to productivity of forest lands. The conclusions and summary statements given here result from the analysis of 647 samples mechanically chosen from a total of 4,821 owners of forest land in the five units.

1. The industrial owners represent less than 1 per cent of the total number of owners, but control about 35 percent of the total forest land and 79 percent of the pine forest land.

2. The non-industrial owners, therefore, represent over 99 percent of the total number of owners, but own only about 65 percent of the total forest land and 21 percent of the pine forest land.

3. The timber on industrially owned land is larger in size than that on either of the other two classes of ownership. Over one-fourth of the pine forest land in industrial ownerships is supporting timber of sawlog size (13 inches d.b.h., and over), while less than one-tenth of such lands in the other ownership classes has timber of this size.

4. Over 98 percent of the industrial lands are under cooperative agreement for fire protection in the states where protection is available. Non-industrial owners are not cooperating with state organizations in fire protection. However, in the areas where privately owned land is interspersed with industrial land, it is receiving indirect protection against fires.

5. In the States of Arkansas, Mississippi, and Louisiana, the non-industrial owners are producing pine at the rate of 31, 33, and 40 percent of their full capacity, respectively. Comparable percentages for the industrial owners are 51, 32, and 53, respectively.

6. Most large industrial owners are showing a definite interest in forest conservation by gradually increasing the size of their holdings, and by applying cutting practices which maintain or increase the forest capital on their lands. The small industrial owners and some of the large industrial owners are not increasing the size of their holdings, and their current cutting methods are rapidly depleting the pine timber on their lands.

7. In two-thirds of the cases in which owners took a negative attitude toward forest improvement practices, the reasons cited were incom-

petency to carry on forest practices, and inability to spare the necessary time involved to do the work.

8. Current cutting practices have so depleted the forest capital on non-industrial lands that they are producing only about one-third of their potential capacity. Type of cutting contracts, rather than the class of product removed, is responsible for the existing condition.

9. On non-industrially owned lands, timber production is higher where the owner is interested in timber growing in conjunction with agriculture.

10. Over half of the non-industrial owners live on their property, and control 43 percent of the total non-industrial forest land. Resident and adjacent owners comprise 87 percent of the number of non-industrial owners, and control 80 percent of the non-industrial forest land.

11. Ownership under the same title, held over a long period of time, has a slightly higher productivity rating than lands held for shorter periods.

12. There was no significant relationship between occupation of the various occupational groups or of residence of the owner, to forest productivity.

The facts heretofore presented seem to indicate that in the shortleaf-loblolly pine type of the South, past management practices were producing less than half of the pine which the land was capable of growing. Recent indications are that particularly large industrial owners are doing a much better job than they did a few years ago, indicating that the amount of timber produced in the future will be greater than has been grown in the recent past. Heavy cutting and fire have been responsible for the low productivity at present indicated throughout the region.

On a large portion of the non-industrially owned lands the type of cutting contracts rather than the type of products removed has been responsible for poor cutting practices. This has been true on a few industrial ownership, but not many. This overcutting has often reduced the seed production possibilities to such an extent that the original pine stands are being replaced by poor quality hardwoods.

Based on the facts of the investigation, it is evident that there is a real lack of understanding among the non-industrial landowners as to what constitutes proper forest management. Very few of them seem to realize that a periodic income can be had every 10 or 15 years from properly managed forest land. To them, a timber sale is something to be made once in a lifetime. Here, we feel, is one of the outstanding opportunities for improving forest practices by increased education and well-placed and well-advertised demonstrations of proper forest cutting.

Inadequate fire protection was given by many owners as a reason for heavy cutting of their forests. Many of them felt that if selective cutting were practiced it would only be a short time before a fire would get into the slash and destroy the residual stand. They did not feel they were justified in leaving small-sized trees to grow, when the chances were that fire would destroy them. This indicates the desirability, really the necessity, of more complete fire protection in order to assure the best possible future forest development. This opinion was, of course, almost universal among non-resident and adjacent owners who were unable to give their lands any personal protection.

All indications seem to point to the fact that during the past few years interest in forestry and timber growth has been increasing to a marked degree. The necessity for overproduction to satisfy the demands of war has done two things: it has depleted many of our forest stands, particularly those controlled in small holdings; and it has made clear to many people the need for future forest protection. Proper education in forest practices and greatly increased efforts toward complete fire protection would, no doubt, make the shortleaf-loblolly pine region of the South one of the most productive in the nation.

APPENDIX

FORMS USED FOR COLLECTING INFORMATION IN THE FIELD

LAES Project No. 507

OWNERSHIP INVENTORY

Form 20—Revised 6/5/42.

Work Unit______________________________

Date Copied______________________, 194___

Ward Number______________________________

Ownership Classification			
R.______	I.______	S.______	1.______
	II.______	J.______	2.______
NR.______	IIIa.______	C.______	
	IIIb.______		
	IIIc.______		
	IIId.______		

Name of Owner______________________________________ Owner No.__________

Address ____

____

Total acreage__________; Forested acreage__________; Agric. acreage__________

Assessed value of forest______________; Am't. taxes on forest______________

Homestead tax exemption: Yes______; No______

Location of Ownership:

In T.______, R.______

in S.______, ____

in S.______, ____

in S.______, ____

in S.______, ____

in S.______, ____

In T.______, R.______

in S.______, ____

in S.______, ____

in S.______, ____

in S.______, ____

in S.______, ____

__________________Description completed above

__________________Description continued on Form 21 for__________sheets

LAES Project 507

OWNERSHIP QUESTIONNAIRE: CLASSES 1 AND II

Form 41—Revised 9/5/42

Work Unit______________________________ Ownership Classification

R.__________ I.__________ S.__________ 1.______

Owner No.______________ NR.__________ II.__________ J.__________ 2.______

C.__________

Location of land: T.__________R.__________
Sections______________________________

1. Name of owner______________________________a. white______1a.
b. colored______1b.

2. Address of owner______________________________ 2.
____

3. Residence of owner______________________________
______________________________ 3.

4. Occupation of the owner__________(5) Approx. age______years. 4 & 5.

6. How many persons have an interest in the ownership?__________ 6.

7. Has owner delegated administration of the tract? Yes______No______ 7.
If "Yes", a. To whom? Name______________________________ a.
Address______________________________
b. Distance of residence from forest land,__________miles b.

8. Total land area owned in unit:__________acres
Forest acres owned in unit:__________ 8.

9. Primary ownership objective is 9.
a. Farming a.
i. by owner . . . . ______ai.
ii. by tenant . . . . ______aii.
b. Explored oil or mineral values . . . . ______b.
c. Existing timber values . . . . ______c.
d. Timber growing values . . . . ______d.
e. Speculative values . . . . ______e.
f. Grazing values . . . . ______f.
g. Other values . . . . ______g.

10. In what years have commercial
cuttings been made? ______, ______, ______ 10.
When timber was sold:
a. seller urged buyer to make the purchase . . . . ______ a.
b. buyer urged seller to make sale . . . . ______ b.
c. seller knew that timber is sold on a partial cut basis . ______ c.
d. buyer proposed to cut timber on a partial cut basis: Yes______ d.
No______
e. seller was interested in continuous timber production . ______ e.
f. seller was interested mainly in maximum present income______ f.
g. at time of sale, income was badly needed for______________ g.
h. sale was conducted on following basis: lump sum . . . ______ h.
unit . . . . ______
i. timber was utilized by______________________________
Permanent sawmill___. Temporary sawmill___. Pulpwood mill___
tie, pole or piling plant___. Other___
i. timber was cut by______________________________
ii. timber sale was negotiated by______________________________
j. what minimum diameter limit was specified in the cutting
contract . . . . butt______
dbh

11. Is the owner opposed to the sale of pulpwood in accordance with current practices? a. Yes________11.
b. No________11b.

12. Owner uses woods primarily for the following purpose:
a. to meet farm needs for fuel, posts, etc.________12a.
b. as commercial timber land . . . . .________12b.
c. for both of the above purposes . . . . .________12c.

13. Has owner practiced any forestry . . . . Yes________
No________13.

(If answer is *yes,* check one or more below)
a. puts out fire when he finds it on his or other's land .________a.
b. installed improvements designed to keep fire out . . .________b.
c. has cooperative agreement with State Forestry Division in fire control . . . . .________c.
d. has planted pine trees . . . . .________d.
e. has thinned stands . . . . .________e.
f. has pruned trees . . . . .________f.
g. specified a minimum diam. limit on a timber sale in excess of 9″ stump d.i.b. . . . . .________g.
h. marked trees to be removed in a commercial sale so that stand was improved by cutting . . . . .________h.
i. practiced light or controlled burning . . . . .________i.
j. marked trees to act as seed trees . . . . .________j.
k. cut as fuelwood only trees of poor form and low value______k.
l. other practices ________________________________l.
(If answer is *no,* check one or more below)
m. believed woods need no care in order to produce value______m.
n. believed forestry expenditures not economically justified because:______________________________n.
o. not competent to conduct forestry practices . . . . . . .________o.
p. places high value on leisure time . . . . .________p.
q. unable to spare time for necessary labor . . . . .________q.
r. does not have necessary money for cash outlay required______r.
s. not interested in his forest land .________s.

14. a. Is owner aware that services of Extension Forester are available? Yes______; No______ a.
b. Is owner willing to avail himself of such public advice?
Yes______; No______

15. Does fuelwood cutting occur annually on the forest land?
Yes______; No______ 15.

16. Present owner acquired title in the year (s) ________________ 16.

17. He acquired title to land by: a. purchase . . . . .________ 17a.
b. foreclosure . . . . .________ b.
i. land was divided into
____________parcels i.

Date of interview________________ ______________________
(Signature of interviewer)

6/8/43 LAES Project 507 Form 43

OWNERSHIP QUESTIONNAIRE FOR CLASS III

Parish____________ Wd.__________

Work Unit ____________________

Date of field work____________________

Ownership Classification			
R.____	I.____	S.____	1.____
	II.____	J.____	2.____
NR.____	IIIa.____	C.____	
	IIIb.____		
	IIIc.____		
	IIId.____		

Location: T______. R______. Sec.____________

1. Name of owner______________________________ 1.
2. Address of owner______________________________ 2.
3. Location of industrial operation______________________ 3.
4. Major product______________________________ 4.
5. Approx. average annual units of product mfgd.____________ 5.
6. If owner is a corporation, is it a "one man," family, or open corporation? . . . . one man______ 6.
   family ______
   open ______
7. Length of haul from forest land to industrial location:
   a. shortest haul:______truck miles; ______rail miles 7.
   b. longest haul: ______truck miles; ______rail miles
   c. number of connecting railroads in haul________
8. Total land area owned in this project unit . . . . ________ac. 8.
9. Number of year (s) land has been owned____________________ 9.
10. Who supervises woods operation? graduate forester________10.
    Name____________________ experienced woodsman________
11. Has the owner practiced forestry on land held in fee simple? Yes________11.
    No________

    (*If answer is YES,* check one or more below)

    a. installed woods improvements to keep out fire, but does not cooperate with State Division of Forestry in protection . . . . ________ a.
    b. cooperates with State Forestry Division in fire control ________
    c. planted trees within the last 10 years . . . . ________ c.
    d. thinned stands . . . . ________ d.
    e. pruned trees . . . . ________ e.
    f. marked trees to be cut from own land so as to improve condition of the stand. . . . . ________ f.
    g. use a minimum diameter limit in timber cutting . . . ________ g.
       i. what was specified minimum diameter?______in. dbh
    h. marked trees to act as seed trees . . . . ________ h.
12. *If answer to No. 11 is no,* check one or more below.
    a. owner was liquidating his forest assets because:______________ a.

i. there is no way in which he can secure a perpetual timber supply for his mill................ ________ i.
ii. he wishes to get out of the business............ ________ ii.
iii. they provide the only available source of timber to meet his existing requirements................ ________ iii.
iv. high carrying charges force him to liquidate..... ________ iv.
b. in the future, sufficient timber to run his mill can be obtained from lands not owned by this owner ________ b.
c. future effects of taxation are too uncertain.......... ________ c.
d. he believes markets for his product are shrinking... ________ d.
e. permanent forest management is too expensive in the long run market outlook...................... ________ e.
f. owner considers fire danger too great to warrant forestry .... ________ f.
g. other reasons: ________________________________ g.
____

13. a. If forest area owned by the industrial unit is too small to warrant employing a full time forester, would the management be willing to employ a forester on a short time or temporary basis?.......Yes ________ a.
No ________
b. If the industrial unit does not own sufficient forest land to supply its timber needs, would it be willing to enter into contractual agreements with private owners in the vicinity of the mill whereby the land would be leased and the leasee would then practice forestry, rental to be paid in the form of a share of stumpage returns? .... Yes ________; No ________ b.
c. If the forest lands are depleted of forest capital would the company borrow money at not more than 4% interest in order to rehabilitate its land? Yes ________ c.
No ________
14. Total assessed value of forest land $________; per acre $ ________ 14.
15. Total amount of taxes assessed to it $________; per acre $ ________ 15.
16. What is the present condition of the industrial unit's forest capital? 16.
(Enter percentages obtained from "% of Strip" line on Form 60.)

Stand Characteristic	*% of Area*
A. Species composition:	
1. More than 75% hardwoods..............	________
2. 25% to 50% pine......................	________
3. 50% to 75% pine......................	________
4. Over 75% pine........................	________
Total...................................	100%
B. Stand density:	
1. Severely depleted	________

2. Sparsely stocked	________
3. Moderately stocked	________
4. Densely stocked	________
Total	100%

C. Stand size:

1. Regeneration	________
2. Saplings	________
3. Merchantable pulpwood	________
4. Merchantable sawtimber	________
Total	100%

D. Condition of cutting:

Cut:

1. Clear-cutting	________
2. Seed tree cutting	________
3. Minimum diameter limit cutting	________
4. Selective cutting	________
Total	100%

Form 45

LAES Project No. 507

____
(owner's name)

Description of land

________________Parish
________________Sec.____, T.____, R.____
________________Sec.____, T.____, R.____

My present Residence is:________________________________
(City or town) (State)

My occupation is:________________________ My age is____

(Check one) a.___. I am the sole owner of the above described tract (s)
b.___. I own the above tract (s) jointly with________ (number) other persons.

Administration of the property has been delegated to:

____
(Name)

____
(Address)

The property is for sale, provided the price is high enough.

____________ yes ____________ no

The principal reason for continuing to retain title to the land is:
(check one or more)

_____for farming
_____for timber now on it
_____for continuous timber growth
_____for oil or minerals

_____for_______________________________
(please specify if other
than those given above)

The last commercial timber cutting was made on this land in 19_____

The timber was purchased by_______________________________________
(Name of sawmill, pulp company or other buyer)

Timber was sold down to a diameter of (check one)
_____6″; _____8″; _____10″; _____12″

Property was acquired by me in 19_____, by: _____purchase
_____inheritance
_____foreclosure

It is understood that the replies you make to the questions asked above or below do not in any way constitute a legal agreement. Your answers are used merely for purposes of information.

Would you be interested in using the services of a forester to mark trees for cutting, supervise cutting, and scale the timber cut, provided the cost of his services did not exceed 10% of the gross stumpage value? (By using the services of a forester, your lands would remain in productive condition for continued timber growth after each cutting.)

_______Yes. _______No.

Would you be interested in pooling your forest land with that of other owners in the area where it is located, to be handled on a cooperative basis by a forester who would supervise cutting, mark timber, market it, and act as manager of the property?

_______Yes. _______No.

Would you be interested in leasing your land on a long term basis to an individual or corporation who would handle the management of the area, on the basis of good forestry practices, with rental to be paid in the form of a share of the stumpage returns whenever timber is sold?

_______Yes. _______No.

LAES PROJECT NO. 507

FOREST CAPITAL CLASSIFICATION

Form 60—Revised 7/1/42

Work Unit _______________Date_______________Crew_______________
Owner_______________________No._______For. Acres Owned_______
Strip begun:____
_____________________________________; Sec._____ T._____ R._____
Bearing__________; _______chains; bearing__________; _______chains;
Bearing__________; _______chains; bearing__________; _______chains;
Strip begun:_____________________________; Sec._____ T._____ R._____
Bearing__________; _______chains; bearing__________; _______chains;
Bearing__________; _______chains; bearing__________; _______chains;

Chainage	Composition				Density				Size				Cutting					Remarks
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	5	
0																		
5																		
10																		
15																		
20																		
25																		
30																		
35																		
40																		
45																		
50																		
55																		
60																		
65																		
70																		
75																		
80																		
Total Plots																		
% of Plots																		

Louisiana Bulletin No. 394 August, 1945

FEEDING BLACKSTRAP MOLASSES TO FATTENING STEERS

By

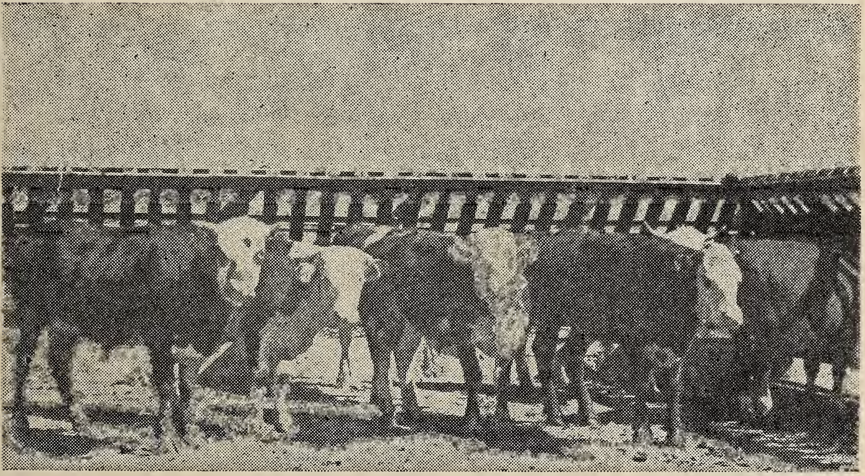
C. I. Bray, M. G. Snell, F. L. Morrison and M. E. Jackson

in cooperation with

Swift and Co.—Lake Charles, La.

and

United States Department of Agriculture



Light Weight Steers Fed Corn, Rice Products and Molasses With Rice Straw

LOUISIANA STATE UNIVERSITY

and

Agricultural and Mechanical College

Agricultural Experiment Stations

W. G. Taggart, *Director*

SUMMARY

1. The value of blackstrap molasses compared to corn for fattening steers varies considerably, depending on conditions. In tests made by the Louisiana Experiment Station in 1939-1942, molasses had a calculated replacement value of about 85% that of corn. In individual tests the value has ranged from around 60% to better than 100% the value of corn.

2. Experiments at this and other stations indicate that molasses is used most efficiently when fed at around 3 to 4 pounds per head daily (about $\frac{1}{3}$ gallon). In the 1939-1941 experiments molasses made the largest gains when fed at the rate of 4 pounds a day, but was slightly more profitable when fed at 8 pounds a day. There was no great difference in feeding value when fed at the rate of either 2, 6 or 8 pounds daily.

3. In some tests in other states molasses has not appeared to be satisfactory when fed with large amounts of silage. In digestion trials at the Louisiana Station there was little difference in digestibility whether molasses was fed in silage rations or fed without silage, although the molasses was slightly more valuable when fed without silage.

4. Blackstrap molasses is strictly a carbohydrate feed and should be fed with an adequate amount of protein supplement, such as cottonseed meal. Cottonseed meal is also high in phosphorus, which is lacking in molasses.

5. Blackstrap molasses appears to be more satisfactory when combined with certain feeds rather than with others. Louisiana experiments indicate that molasses combines satisfactorily with rice bran and rice polish. Experiments elsewhere show that molasses makes a satisfactory combination with oats or with cottonseed meal and hulls. Molasses may not be entirely satisfactory when added to a heavy feed of corn or with large amounts of corn silage.

6. Louisiana cattle feeders will find molasses a profitable feed when bought in bulk at the sugar factory at prices from 6 to 10 cents per gallon, when molasses is again released for farm use.

7. Steers fed molasses usually eat a little more roughage than steers fed on similar rations without molasses. The difference, however, is not great enough to be of any economic importance.

FEEDING BLACKSTRAP MOLASSES TO FATTENING STEERS

By C. I. Bray, M. G. Snell††, F. L. Morrison†, and M. E. Jackson†

HISTORY OF MOLASSES FEEDING

The use of low-grade molasses as a feed for livestock began over 100 years ago in the sugar beet sections of Europe. The first beet sugar factory was built in Silesia in 1801. In 1811 Napoleon issued an edict enforcing the planting of beets in France and the establishment of beet sugar factories to avoid having to import sugar. By the end of the Napoleonic era in 1815 the central European countries had found that sugar beet production fitted in well with improved systems of crop rotation, and the beet sugar industry developed with amazing rapidity. As the molasses from the beet factories was not suitable for human consumption the question of how to dispose of this molasses was of particular importance. Since countries like France, Holland, Germany, and England have only limited amounts of concentrates for feeding livestock, molasses was used in various ways and found to be a satisfactory feed, especially for feeding work horses and for fattening cattle. In Paris thousands of cab and omnibus horses were fed molasses. The health of the horses appeared to be improved, and the saving in feed costs was enormous. Dr. Lewis S. Ware, chemist and editor of Philadelphia, Pa., who did much to establish the beet sugar industry in America, has recorded much of this early history in his book, *Cattle Feeding With Sugar Beets, Sugar, Molasses and Sugar Beet Residuum.** The following from Ware's book has been widely quoted in bulletins on molasses feeding.

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*Lewis S. Ware. Cattle Feeding With Sugar Beets, Sugar, Molasses and Sugar Beet Residuum.

"The first one to suggest molasses as a feed was Hermstadt, in 1811. A special forage was, as early as 1830, made of chopped straw and 100 kilos (18.7 gallons) of molasses, as a daily ration for 80 cattle, 2000 sheep and 20 horses. In Germany, Stockhardt, in 1850, fed to cattle a mixture of molasses, oat-straw and hay. In 1860 the use of molasses became very general in France and Russia. In England, the use of molasses for cattle (which began in 1855) was not general before 1870. In Germany, in 1895, out of 220 beet sugar factories, 130 sold their molasses for feeding purposes to the extent of 10% to 100% of their production. Twelve of these establishments got rid of all their molasses in this way."

†On military leave.

††Dr. M. G. Snell, called into military service Feb., 1941. Commissioned as a Major in the Army, he was assigned to duty in the Philippines in Nov., 1941. He was in active service until the fall of Corregidor, was taken prisoner by the Japanese and was reported missing following the torpedoing of a Japanese prison ship Dec. 15, 1944.

USE OF CANE MOLASSES FOR STOCK FEEDING FOLLOWS COLLAPSE OF MOLASSES MARKET

Cane molasses, on the other hand, being suitable for human food and used a great deal as a sugar substitute, was not used for stock feeding in America to any great extent until after 1890. By this time more sugar was being produced, and as more efficient methods were being developed for extracting sugar from sugar cane, there was a greater surplus of the lower grades of molasses. The Louisiana Planter and Sugar Manufacturer published in 1888 by John Dymond, a sugar planter near New Orleans, furnishes some information regarding the beginning of molasses feeding in Louisiana. The molasses market was seriously overstocked in 1890-91, and the net value at the sugar mills was around 2 cents per gallon. John Dymond, who had fed molasses to work mules in 1882-1883, wrote in February 1891,

> "Molasses has now fallen so low as to become practically valueless and unless some means of its disposal shall be made apparent the medium and lower grades will have to be thrown away. In England a large amount of the lowest grades of molasses is used as food for animals."[48]

It was suggested that alcohol plants and distilleries should be established in the sugar cane area to make use of surplus molasses. Other suggestions were that molasses might be used as fuel in sugar mills or as fertilizer on cane fields. In 1892 Dymond wrote again, "Molasses is now as low or lower than ever—2 cents a gallon hardly being obtainable for it."[49] But the situation become worse and in 1895 the Louisiana Planter reprinted an article from the Country Gentleman which stated,

> "Throughout the sugar districts of Louisiana molasses is emptied into the streams and skimming ditches to get rid of it, being of such little value it does not pay to barrel it for transportation. Molasses is worth in New Orleans 1½¢ to 2¢ per gallon. Thousands upon thousands of barrels of molasses are now wasted."[50]

A writer from St. Louis advised that molasses be advertised among Texas cattlemen to encourage them to use molasses for fattening cattle.[51] In April 1895, at a meeting of the Louisiana Sugar Planters Association,

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* According to the Statistical Abstracts of the United States and other sources the estimated consumption of sugar in the United States has increased from 8.8 pounds per capita in 1823 to 24.4 pounds in 1866; 35.5 pounds in 1875; 60.8 pounds in 1890; 81.8 pounds in 1910; 110 pounds in 1925; and 115.1 pounds in 1941. This includes sugar used for all purposes as pastry, confectionery, soft drinks, etc., as well as table sugar.

[48] La. Planter. Feb. 14, 1891.

[49] La. Planter. Aug. 20, 1892.

[50] La. Planter. Apr. 13, 1895.

[51] La. Planter. Aug. 8, 1891.

which was the leading agricultural association in the state, the principal topic was, The Use of Molasses as Stock Feed. John Dymond stated, "The best we can get for our molasses is 1/12¢ per pound (1¢ per gallon). We are buying corn at 1¢ per pound."[52] At a later meeting one planter reported, "I gave away molasses last year for 50¢ per barrel and ran into the ditch between 12,000 and 15,000 gallons."[53] Another planter had put signs on his gate saying, "Molasses given away."[53]

In January 1898 an editorial in the Louisiana Planter stated that, "Most of our planters are selling their molasses at about one cent per gallon. A prominent planter told us some two or three months ago that he was then throwing his molasses into the ditch simply because he had no tank room. Thousands of mules, horses, and cattle have had little other food during the past year and have done well. It ill becomes the Louisiana planter to throw his molasses away or sell it at ten per cent of its value if the English farmer can afford to send to Louisiana for molasses to feed his cattle in England."[54] In May 1898 a similar editorial stated, "Corn in Louisiana is 42 cents per bushel, molasses 1 cent per gallon. Hundreds of thousands of gallons are sent to Europe and sold to stock feeders at nine cents per gallon."[55]

During this period, the sugar planters, who were having financial difficulties, because of low sugar prices, began to feed molasses to their work stock to replace high priced grain feeds. Amounts fed ranged from two or three pounds to over twenty pounds per head per day, the average daily feed of molasses being about one gallon, or 11.65 pounds. Various plantation owners reported that they were putting molasses in troughs in their feed lots or pastures and letting their mules eat it free choice. The health of the mules appeared to be much improved, colic was no longer prevalent, and the cost of feed was reduced from 20% to 50% per year.[52]

Among the members of the Louisiana Station staff who helped to promote the feeding of molasses were Dr. W. C. Stubbs, Director, 1888-1905, Dr. W. R. Dodson, Director 1905-20, 1921-28, R. E. Blouin, Assistant Director, C. A. Browne, Jr., Chemist, J. E. Halligan, State Chemist, 1904-1912, and Dr. W. L. Dalrymple, State Veterinarian. Dr. Dalrymple particularly encouraged the feeding of molasses to plantation work stock.

It is not certain when stockmen in this country began to feed blackstrap molasses to fattening cattle. All early references in the Louisiana Planter were copied from European agricultural journals and referred only to beet molasses. Possibly the first experiment in feeding molasses to fattening cattle in America was reported by Gulley and Carson

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[52] La. Planter. Apr. 27, 1895.
[53] La. Planter. June 22, 1895.
[54] La. Planter. Jan. 29, 1898.
[55] La. Planter. May 28, 1898.

(Texas)[17] in 1890. They fed one-half pint molasses per day with cottonseed meal and hulls or cottonseed meal and silage to steers, with favorable results. The principal idea in feeding molasses appears to have been to increase feed consumption. In 1895, Dr. W. C. Stubbs and D. N. Barrow[38] fed one quart of molasses daily with cottonseed meal and hulls to beef steers at the Louisiana station and reported profitable gains of over 3 pounds per head per day. They stated that molasses (common black centrifugals) could be bought in New Orleans at 5¢ per gallon or at a lower price in bulk, and that this molasses could be used to advantage in fattening cattle.

During the first ten years of the century a number of experiment stations made reports on the feeding value of molasses. The publication of Henry's *Feeds and Feeding* in 1898 had done a great deal to arouse interest in the balancing of rations for farm livestock and in the study of nutritive values and deficiencies in feeds. From 1904 to 1908, Craig, Marshall and Burns of the Texas station published four bulletins on steer feeding, which included work on adding molasses to rations of cottonseed meal and hulls in comparison with corn. The price in Texas during this time appears to have been 6¢ to 10¢ per gallon, as compared to 12¢ and 14¢ in 1890. In the early years only small amounts of molasses were fed but by 1908 they were feeding as high as one gallon per day to fattening steers. In 1906 Dr. Dalrymple published Louisiana Bulletin No. 86, Available Stock Foods,[12] which included several pages on the uses and value of molasses for livestock feeding. Lindsey in Massachusetts[23] and Patterson and Outwater in Maryland[27] reported on molasses feeding in 1907.

DEVELOPMENT OF MOLASSES FEED MIXTURES

Some objections in regard to feeding molasses are that liquid molasses is inconvenient for the small feeder to handle, attracts flies in fly time, may become smeared over the heads and forequarters of the livestock; is subject to fermentation in hot weather, and hard to pour in freezing weather. In European countries, numerous attempts were made to combine molasses with absorbent materials so as to make a feed that would be easy to handle or to ship in bags. Cut straw and cut hay were among the earliest feeds used, but while these were satisfactory for farm use they were too bulky for economical transportation and did not absorb a great deal of molasses. Peat, which is used for fuel in parts of Europe, was found to absorb three or four times its weight of molasses to form a dry feed. This peat-molasses or "Torf-Melasse" was first tried out in 1895 and became popular in Europe by 1896. In 1902 George Hughes in England patented "Molasquit," a mixture of molasses with the fine pith from sugar cane, which when dried would absorb four times its weight of molasses. This type of feed has been produced by mills in Louisiana (see pages 20-23). Dried moss was also used in Europe to combine with molasses forming "Molassine" feeds. Dried blood from the packing houses and wheat products were also used to some extent. The objection to using such materials as moss and peat was that as these had little or no feeding value it meant an unnecessary expense for freight and handling.

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[17] Gulley, F. A. & J. W. Carson. 1890. Feed Experiments. Tex. Expt. Sta. Bul. 10. "A cheap grade of molasses may be procured at the sugar houses at from 12 to 14 cents per gallon. We are led to conclude that cheap molasses may be added to cottonseed hulls and meal but not to silage and meal." Gulley and Carson seem to have intended the molasses to be used as a sweetener to encourage the cattle to eat more hulls or silage.

MOLASSES FEED MIXTURES INCREASED DEMAND FOR MOLASSES

Since there is usually a surplus of feeding stuffs in America there was no need in this country to use worthless absorbents to mix with molasses. The molasses could as easily be mixed with other nutritious feeds such as corn or mill products to make ready-mixed feeds convenient for those feeding only a few head of dairy cows or work animals. A few of these molasses feeds or "sweet feeds" were apparently put on the market around 1901 to 1903, Sucrene Dairy and Horse Feeds, Molac Sugar Feeds, Hammond Dairy Feed, being mentioned at that time. One of the first molasses feeds sold in the east was manufactured by Wogan Brothers of New Orleans in 1902. By 1908 a number of similar feeds were reported in feed-inspection bulletins from various stations. These molasses feeds became so popular that there was a rapid increase in the price of molasses. Halligan, chief Chemist[18] (La. Expt. Sta.) reported, "While twelve years ago (1897) Louisiana blackstrap molasses was almost unsaleable, the demand has become so great that it is now (1909) selling for $19.00 to $21.00 per ton retail. Louisiana blackstrap has become so scarce that Louisiana feed mixers are purchasing "second" molasses for feeding purposes."

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*Analyses of Commercial Feedstuffs. La. Bulletin 88. 1906.
**Analyses of Commercial Feedstuffs. La. Bulletin 114. 1910.

In 1910 Halligan warned against the use of spoiled feeds in making molasses feeds. He wrote, "Fermented corn, moldy corn, rancid rice bran, moldy or improperly cured hays, and other unsound primary products should be avoided. Unsound materials when employed in compounding molasses feeds usually result in a deteriorated product when it is put upon the market. Fermented molasses should be sterilized before incorporating it with the balance of the feed." He also recommended artificial drying for the feeds after mixing to prevent fermentation.

[39] Taussig estimates, "100 million gallons of blackstrap molasses are consumed annually in the United States in the manufacture of molasses feeds. He estimates that over 60 per cent of the mixed feeds used in the cattle and dairy industry contain molasses. In normal times about 180 million gallons are distilled into alcohol and similar products." Due to the need for alcohol in manufacturing munitions very little molasses will be available for feeding purposes until after the war.

CARE NECESSARY IN BUYING MOLASSES FEEDS

Unfortunately, molasses made an excellent camouflage for many low-grade substances sometimes put into mixed feeds. Most objectionable of these were all kinds of weed seeds which thus became widely distributed over the farms of the nation. Halligan, when in charge of feed analyses in Louisiana, found oat offal, ground corn stalks, ground straw, refuse from flour mills, oat hulls, ground peanut hulls, rice hulls, and chaff from pipe factories, as well as large quantities of weed seeds and other refuse in molasses feeds. Reputable manufacturers of the better molasses feeds were reported to be making a conscientious effort to keep their feeds free of such undesirable ingredients. The practice of including weed seeds in commercial feeds was by no means confined to the makers of molasses feeds, but because molasses gave these mixed feeds such a desirable flavor and color it was easier to include low-grade "fillers" without their being easily recognized. Feedstuffs inspection has developed to where fairly effective control is maintained over commercial feed mixtures, but some low grade molasses mixtures are still sold. Buyers should see that inspection tags are on all commercial feeds sold in Louisiana and should be guided by the reports of the feed inspection department. A molasses feed should not contain over 12% moisture and 10% is preferable.

NATURE AND COMPOSITION OF BLACKSTRAP MOLASSES

In the manufacture of sugar, after the cane juice has been evaporated in vacuum pans and the sugar crystalized, the "massecuite," a mixture of sugar crystals and syrup or "mother liquor," is put into centrifugal machines and rotated at high speeds. The centrifugal machine consists of a circular revolving basket, lined with a fine metal screen. In centrifuging, the sugar crystals remain in the machine and the molasses is thrown off. This first molasses is collected and centrifuged a second and third time. The final or "third" molasses, which is thick and dark colored became known as "blackstrap." It contains about 21% of water, 60% of sugars, 9% ash and about 10% of miscellaneous organic substances of little feeding value. The principal difference between cane molasses and beet molasses is that beet molasses contains more mineral matter or ash (mainly potash salts) and more non-saccharine organic matter, with 14% less sugar. The following comparison of blackstrap and beet molasses was given by Dr. C. A. Browne, Jr., former State Chemist of Louisiana.[56]

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[56] La. Planter. Mar. 4, 1905.

COMPARATIVE ANALYSIS OF CANE (BLACKSTRAP) MOLASSES AND BEET MOLASSES

	Cane Molasses (Blackstrap)	*Beet Molasses*
Water	20.93	23.70
Cane sugar	30.73	46.70
Reducing sugars	29.67	0.60
Ash (salts)	8.85	13.20
Organic (non-sugar)	9.82	15.80

The composition of cane molasses will vary a little with the variety of cane and the process of manufacture, but should contain at least 48% of sugar expressed as invert sugar and when diluted with an equal weight of water shall test not less than 39.75 degrees Brix (79.5% dry matter). The value of molasses for feeding is in proportion to the sugar content. The ash in beet molasses is mainly potash salts which is the principal reason why beet molasses has not the palatability of cane molasses.

PRODUCTION OF BEET MOLASSES AND CANE MOLASSES IN THE UNITED STATES 1910-1941**

Years	*Beet Molasses* (gal)*	*Cane Molasses (gal)*
1910-1914	20,910,000	14,824,750
1915-1919	25,350,000	10,673,400
1920-1924	30,510,000	11,110,200
1925-1929	31,980,000	7,835,400
1930-1934	41,880,000	13,765,600
1935-1939	45,600,000	32,038,800
1940-1941	52,275,000	23,764,000

*Beet molasses estimated on the basis of 30 gallons per ton of beet sugar produced.
**Yearbooks, U. S. Department of Agriculture and Agricultural Statistics.

The following table shows the average digestible nutrients in blackstrap molasses and beet molasses as compared to No. 2 corn. On the basis of Morrison's tables, either for total digestible nutrients or for calculated net energy values, cane molasses shows an estimated feeding value of 70.2% that of No. 2 corn. While it is often claimed that molasses is worth as much as corn, pound for pound, it has not shown such values in the average feeding test.

DIGESTIBLE NUTRIENTS IN CANE AND BEET MOLASSES COMPARED TO CORN.
(Morrison. *Feeds and Feeding.*)

	Dry Matter	*Digestible Protein*	*Total Dig. Nutrients*	*Estimated Net Energy*	*Mineral Matter*	*Phosphorus*
Corn No. 2	85.2	7.1	80.6	79.2	1.3	0.27
Cane Molasses*	74.1	0.9	56.6	55.6	9.4	0.06
Beet Molasses	80.6	2.5	58.8	57.8	10.3	0.02

*In Louisiana must contain 79.5% dry matter.

If we look at the above table it is seen that molasses is particularly deficient in protein and phosphorus, even as compared to corn, which is also low in these respects. Molasses should always be fed with a plentiful amount of protein-rich supplements such as cottonseed meal, which is not only high in digestible protein but is relatively high in phosphorus.

METHODS OF FEEDING MOLASSES

Molasses is fed in various ways, depending on the choice or convenience of the feeder. Some of the most common methods are:

1. Fed free choice in open tanks or in self feeders.*
2. Poured into troughs or feed bunks in definite amounts daily, usually with other concentrates.
3. Diluted with water and sprayed or poured on hay or other roughage.
4. Mixed by machine with cut or ground roughage or with concentrates.
5. In commercial molasses feeds.
6. In grass silage or alfalfa silage.

Probably the most common method under average conditions is to feed regular amounts in the feed trough daily. It appears to make little difference whether the molasses is mixed with other concentrates or poured on top of the other feeds. In either case cattle will clean up their troughs so that little molasses is left to attract flies. In the Louisiana experiments reported here this method was used. Feeding in open tanks, free choice, was quite common when molasses sold at two cents a gallon but today is rarely practiced outside of the sugar beet sections. Spraying molasses on fodder may encourage cattle to eat larger amounts of roughage, the objection being that the molasses becomes smeared over the heads, necks, and forequarters of the cattle.

When fattening large numbers of cattle annually, as in the sugar beet sections, feeders frequently have their own feed mixing plants where cut roughage and concentrates are mixed with molasses. These are usually equipped with boilers for heating the molasses with steam to allow uniform mixing. Such equipment would prove too expensive for feeding only small numbers of cattle. The use of molasses to make grass-molasses silage is becoming popular in some sections but the molasses consumed in this way is only a small amount per day.

RESULTS OBTAINED IN FEEDING BLACKSTRAP MOLASSES AT VARIOUS EXPERIMENT STATIONS

EFFECT OF MOLASSES FEEDING ON THE DIGESTIBILITY OF RATIONS

Some investigators have reported[22] that the addition of molasses to a fattening ration lowers the percentage digestibility of the various nutrients. Some of these investigations have been with beet molasses rather than cane molasses. It is generally true that if large amounts of highly digestible carbohydrates are added to a ration there is likely to be some reduction in digestibility of nutrients, if the protein fraction of the ration is not increased in like proportion.[26]

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*A self feeder used at the Minn. Station consisted of a molasses barrel with a three-quarter inch hole near the bottom set in a feed trough so that the molasses would flow out as the steers ate it. Steers that were self fed molasses ate 9 lbs. per day at first but the amount gradually decreased to 3 lbs. per day.

In order to obtain further information on this subject Snell[36] Louisiana, conducted digestion trials with steers to determine the effect of molasses on the digestibility of rations either with or without silage. The variations in digestibility were not great. When molasses was added to a ration containing silage the digestibility of protein was slightly lowered in the silage rations though not in the non-silage rations. Molasses did not affect the digestion of fat (ether extract), and the digestibility of carbohydrates was depressed only slightly in either ration.

In 1931 Snell replaced corn with molasses at the rate of 15%, 30%, 45%, and 100% of the corn in a ration of ground ear corn, cottonseed meal and hay. At the 15% level the digestibility of protein appeared to be increased but with larger amounts the digestibility was slightly decreased. With fat (ether extract) there was a slight increase in digestibility in proportion to the amount of molasses fed. With the carbohydrates (nitrogen-free-extract) there was an apparent increase in digestibility due to molasses feeding up to the 45% level but at the 100% level the digestibility was lowered. With crude fibre there was an increase in digestibility at the 30% and 45% levels.

These results would indicate that in normal steer fattening rations there is not likely to be any serious lowering of digestibility due to feeding a good grade of fresh blackstrap molasses in reasonable amounts.

What Proportion of Molasses is Most Satisfactory to Feed

From the feeder's standpoint the most satisfactory amount to feed is that which will make the greatest profit. Profits, however, will depend largely on the price of molasses compared to other feeds. Rations may also be compared on the basis of daily gains, the sale price of the cattle, or the feed required per pound of gain. Usually, cattle making the highest gains per day will be the most economical in use of feed and will generally bring the highest sale price, but will not necessarily make the greatest profit.

Briggs and Heller[4] Oklahoma, working with lambs found that with 10% molasses in a ration there was no material effect on digestibility but in a 25% molasses ration there was a material decrease. Lindsey and Smith[57] Mass., reported a definite decrease in digestibility from feeding molasses while Patterson and Outwater[27] Maryland, reported that molasses feeding increased the apparent digestibility of hay. Williams[58] Penn., working with dairy cows found no consistent decrease in digestibility, excepting a slight decrease in digestibility of protein.

[57] Massachusetts 22nd Annual Report.

[58] Williams, Paul S. Journal of Dairy Science. Vol. 8. pp. 84-104.

[26] Morrison. Feeds and Feeding. pp. 68-69.

An experiment conducted by Snell (La.) in 1939-41 (pages 23-37) showed little difference in the feeding value of molasses when fed at the rate of 2, 6, or 8 pounds per day; replacing equal weights of rice by-products (page 37). The steers receiving molasses made higher gains per day than those fed rice products and cottonseed meal without molasses. The average for three years showed slightly higher daily gains in favor of the cattle getting 4 pounds of molasses daily (1⅓ quarts) with the lot getting 8 pounds ranking second. Lot 6, receiving 8 pounds of molasses (½ of the concentrate ration) ranked first in profit per steer two years and lowest one year with molasses selling a little under 10¢ per gallon. Lot 3, receiving 2 pounds of molasses daily, had a slightly higher value per 100 pounds live weight with the other molasses-fed lots a few cents lower. There was only a small variation between lots, indicating that the feeding value of molasses was not greatly different when fed between the limits of 2 to 8 pounds per day. With molasses selling below 10¢ per gallon, it was more profitable to feed the larger amounts.

ADDING MOLASSES TO RATIONS OF COTTONSEED MEAL AND HULLS, COTTONSEED MEAL AND HAY, OR COTTONSEED MEAL AND SILAGE

Some early experiments reported on feeding molasses to steers consisted of adding molasses to rations of cottonseed meal fed with hulls, silage or hay. Such additions usually resulted in increased gains and increased profits, especially when molasses was low in price. Similar results might have been obtained by adding corn or other concentrate feeds. Gulley and Carson, Craig and Marshall, and Marshall and Burns at the Texas station, all reported good results from such feeding. Craig and Marshall fed up to 3 quarts of molasses per day on cottonseed meal and hulls, while Marshall and Burns fed as high as one gallon per day. Five quarts of molasses was found to be too much. With molasses at six to ten cents per gallon, cottonseed meal at $22.00 per ton and corn at 70 cents per bushel the feeding of molasses was economical. Grimes, Alabama station, fed blackstrap molasses in addition to cottonseed meal and Johnson grass hay. The cattle made uniformly higher gains when fed 3 to 4½ pounds of molasses per day. Molasses feeding was profitable in two out of three years with cottonseed meal at $40.00 per ton and molasses at

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Craig and Marshall (Tex.) [8] found that 2 quarts of molasses made higher gains at lower cost than 1 quart per day when fed with meal and hulls. Blizzard and Taylor (Okla.) [2] found no great difference in feeding value when molasses was fed as 53% of the concentrate ration or at a 75% level. Barnett and Goodell (Miss.) [1] reported that 2½ pounds of molasses per day was more profitable than 5.2 pounds per day. Edwards and Massey (Ga.) [13] found 3.3 pounds of molasses more profitable than 6.6 pounds. Also McComas[25] at the Coastal Plains Sta. (Ga.) found a ¼ ration of molasses more efficient than a ½ molasses ration. In Iowa tests[14] cane molasses was added to a corn and silage ration at the rates of 1, 3, and 5 pounds per day. Feeding 1 pound per day was more profitable with molasses at $40 per ton, due to a higher sale price on the finished cattle, but the replacement value of molasses at the 3 pound level was much higher than when either 1 pound or 5 pounds was fed. Thalman, Neb. also reported more profitable gains from 3 lbs. of molasses compared to 6 pounds. Mimeographed Rep. 165.

$30.00 per ton. Templeton and Goodell, Mississippi, added 2.6 pounds and 5.2 pounds of molasses to rations of cottonseed meal, silage and hay. The smaller amount of molasses increased gains and profits. Adding 5.2 pounds of molasses produced greater gains but the lowest profits. Quesenberry[31] (Iberia Station) obtained conflicting results from adding molasses to rations of corn-silage, and cottonseed meal. In 1923-24 molasses increased the gains and sale price but in 1925-1927 the addition of two pounds of molasses decreased gains and increased the feed requirement per 100 pounds gain. McCampbell and Winchester[24] (Kan.) reported lowered gains from adding molasses to a silage and cottonseed meal ration, but with an increase in sale price and slightly higher profits. Jacobs and Duncan[19] (Tenn.) found molasses to be unprofitable at 20 cents per gallon, when added to a ration of cottonseed meal and silage.

WHAT IS BLACKSTRAP MOLASSES WORTH COMPARED TO CORN AND OTHER CONCENTRATES

A study of the results obtained in molasses feeding at seventeen experiment stations reveals a surprising lack of uniformity in results. In some feeding tests molasses has shown a feeding value equal to corn or even higher, while in a few cases molasses has shown extremely low values. It must be emphasized that when compared on the basis of total digestible nutrients or on estimated net energy, molasses has only about 70% the estimated value of corn. In the Louisiana experiments reported in an average of three years experiments (pages 23-37), three groups showed molasses to have an estimated replacement value of around 85% the value of corn, while in one group molasses was apparently better than corn. If we omit some of the most unfavorable tests where there might have been other reasons for the poor showing of molasses, we might conclude that molasses varies from 60% to 100% the value of corn with an average value of about 80% to 85%. Some possible reasons for variations in results are discussed on page 14.

Skinner and King[32] Indiana Station, reported increased gains and greater profits from the use of molasses where corn cost more than molasses. Molasses apparently had a higher value than corn in these tests. A proprietary molasses feed was less profitable than either corn or the corn and molasses mixture. Molasses fed at the rate of 3 pounds daily apparently replaced more than an equivalent weight of other feeds. Barnett and Goodell[1] Miss. 1920, reported that steers fed blackstrap molasses in place of corn made slightly lower gains but the profits were greater from feeding molasses. Molasses had apparently the same replacement value as corn. Tomhave and Bentley[41] Pa., reported that replacing 3.65 pounds of corn with 3.67 pounds of molasses resulted in slightly higher daily gains and a profit of $2.35 more per head, with molasses at $25 per ton and shelled corn at $21.40 per ton. Trowbridge[42] Missouri, found that feeding one pound of cane molasses to a ration of shelled corn, linseed oil meal, corn silage, and alfalfa hay to 2-year-old steers produced increased gains, but gains and profits were lowered when no protein supplement was fed.

On the other hand, Edwards and Massey[13] Ga., found that a mixture of one part molasses to three parts corn had a value of 88% the value of corn and a mixture of equal parts of corn and molasses was worth 74% the value of corn. A simple calculation would show that molasses in these tests was worth just 50% as much as corn. Blizzard and Taylor[2] Okla., did not obtain satisfactory gains feeding corn and molasses compared to corn alone, but found that oats and molasses were almost equal to corn. Gerlaugh[15] Ohio, produced more rapid gains and obtained higher selling prices for cattle self-fed molasses but the gains were not profitable with molasses at $35.00 per ton.

POSSIBLE REASONS FOR UNFAVORABLE RESULTS IN FEEDING MOLASSES

Some of the possible explanations as to why molasses sometimes gives poor results in feeding might be listed as follows:

1. Lack of sufficient protein supplement.
2. Unfavorable feed combinations.
3. Heavy silage feeding, especially with some types of silage.
4. Adding molasses to rations that are already sufficient for good gains.
5. Molasses too high in price.
6. Watered molasses or molasses of poor quality.
7. Possible effect of heavy molasses feeding on health of steers.

Since molasses has a very low protein content and the proteins are presumably of low quality, it should be evident that to feed molasses successfully a good supply of protein supplement is necessary. In some feed tests molasses has been used in place of protein supplement, which is certainly unjustifiable. In other cases the protein supplement has evidently been too low even for balancing a corn ration. Results have generally been most favorable where at least 3 pounds of cottonseed meal was fed per day.

It would appear that molasses does not combine well with some types of silage, especially where a heavy feed of silage is given. In experiments at the Iberia Station where molasses made an unfavorable showing when added to cottonseed meal and silage, the silage was fed at the rate of 45 pounds per day. In one year sorghum and soybean silage was fed, one year sargo-and-soybean silage, and one year corn and soybean silage. In a previous test where the most favorable results were obtained, corn silage was used. In experiments at the Louisiana station in 1929-31 there was apparently little difference in feeding molasses with silage as compared to no silage, but the amount of silage fed was small. The molasses was approximately 5% less valuable when fed with silage as compared to a no-silage ration. Trowbridge[42] Missouri, found in one test that the addition of one pound of molasses per day produced increased daily gains in a corn and hay ration with protein supplement and no silage and a low gain with silage and no protein. The cattle were fed a good quality of legume hay. Gully[17] Texas, reported unfavorably on adding molasses to silage and cottonseed meal.

Results at the Louisiana station seem to indicate that molasses combines favorably with rice polish or rice bran, which is reasonable in view of the fact that these products supply protein and also phosphorus, which are lacking in molasses. Several investigators have reported that oats and molasses make a favorable combination. Briggs and Heller[4] Oklahoma station, reported that oats and molasses made a better combination than corn and molasses. On the other hand, barley and molasses did not appear to make a good combination at the Minnesota station. Molasses appears to combine well with cottonseed meal and hulls. Some of the most favorable results obtained have come from feeding this combination, though some poor results have been obtained also with meal and hulls. According to Morrison the addition of molasses to a full feed of corn properly supplemented has not proved satisfactory. When molasses is added to an already complete ration, the effect is generally to increase the amount of feed eaten without increasing gains or profits. Unfavorable results might be expected also if a similar amount of some other carbohydrate feed was added under the same conditions.[26]

Not a great deal is known about the quality of molasses used in some experiments. Briggs and Heller[4] Oklahoma station, found that molasses in that state varied widely in water content, indicating that water was being added to molasses sold for feeding purposes. Molasses should not contain more than about 21% of water. The molasses used in the Louisiana tests was generally bought directly from the sugar mills in fresh condition and probably was free from fermentation. Fermenting molasses is known to cause trouble in feeding mules and might cause trouble in some cattle rations.

In most feeding experiments there has been no record of undesirable effects from molasses feeding, though a few cases have been noted. In all Louisiana molasses feeding experiments the cattle have appeared to do as well as where no molasses was fed. In one test at Lake Charles, La., 1941-42, two steers had to be removed from one of the molasses fed lots, but the condition was considered due to other causes. At the Ohio station some steers receiving two pounds molasses died or were slaughtered due to bladder trouble. It was not known that these effects were due to molasses feeding, especially as no such effects were observed in steers fed twice or three times as much molasses daily.

EFFECT OF MOLASSES FEEDING ON INTAKE OF ROUGHAGE

A reason often given for feeding molasses is that where molasses is sprinkled on the roughage the consumption of roughage is increased. That is frequently true but it also appears that where the molasses is not fed on the roughage but on the concentrates, the consumption of roughage is greater than where no molasses is fed. In the three year experiment reported on pages 23-41, steers receiving molasses invariably ate more straw daily than when no molasses was fed, though the increase was not more than one pound per day. In 1941-42 where legume hay was fed in racks the cattle receiving molasses ate $\frac{3}{4}$ pounds more hay and almost a pound more rice straw per day. In experiments conducted in 1929-30, cattle fed molasses ate slightly more hay and more silage. This seems to have been true in nearly all tests at other stations but the total increase has not been of any importance.

General Conclusions

Blackstrap molasses is strictly a carbohydrate or fattening feed, low in protein and mineral matter and worth for fattening cattle around 80% to 85% as much as an equal weight of corn if fed in reasonable amounts and with proper supplements. It is not a protein supplement and should not be expected to replace cottonseed meal or similar feeds in a fattening ration.

Feeders within easy trucking distance of a sugar mill will generally find it more economical to buy molasses in bulk during the grinding season as the cost is then considerably lower. Molasses is not a "wonder feed" that can be used to improve any ration regardless of price; it does not change low-grade roughages into valuable feeds, and should be fed in combination with a good protein supplement such as cottonseed meal. It is normally a cheap and economical substitute for corn which can be used to advantage in the cane belt where the price is usually below the price of corn. It appears to give most satisfactory results when fed at the rate of around 4 pounds (1⅓ quarts) per day but may be fed up to 8 pounds per day.

Molasses has been shown to contain a "growth" factor (Ohio Bulletin 463) ; which means that steers receiving a molasses ration may grow more and not put on as much fat. This may explain why cattle fed corn and molasses sometimes bring a slightly lower price than cattle fed corn alone, even when the gains have been equal. Consequently it may be advisable to feed more molasses during the early part of the feeding period rather than at the end of feeding.

FEEDING MOLASSES TO WORK STOCK

In 1929 as there appeared to be an increased interest in using molasses for feeding mules, Snell and Taggart of the Louisiana station[35] began an experiment with sugar farm mules to determine how much molasses per day was most satisfactory for a mule, and the feeding value of molasses compared to corn. In 1929 one mule out of each of 6 teams was fed molasses and the other mule fed corn. Chopped soybean hay was fed as roughage and the molasses was mixed with the chopped hay. The corn-fed mules received 13.6 pounds corn per day as compared to 11 pounds of molasses in the other lot, and gained 81 pounds per head as compared to 46 pounds for the molasses fed group. All mules were in good health and condition, but toward the end of the feeding period the molasses fed mules refused part of their feed and winded easily.

In 1930 another experiment was started with 7 teams of mules, one mule out of each team being fed 3 pounds molasses per day and the other 6 pounds replacing an equal amount of corn. The test ran for 126 days and then the rations were interchanged. The hay was alfalfa hay and soybean hay. The lot receiving 3 pounds molasses gained 4 pounds per head and those receiving six pounds of molasses lost 13 pounds. As the lots were only 10 pounds apart in weight at the end of the test these differences were considered immaterial. It cost 2 cents less per day to feed the 6 pound lot than the lot receiving 3 pounds. In 1931 the experiment was repeated with six teams of mules comparing six pounds of molasses per day with nine pounds. The lot receiving nine pounds gained slightly more than the other lot but the difference was too slight to be significant.

The conclusions reached were that molasses was practically equal to corn for feeding work mules, and that nine pounds was nearly the maximum amount that could be fed with good results. Feeding molasses fresh every day seemed to be preferable to mixing the molasses with the feed in large quantities. No colic was observed among the mules fed molasses. Evidently blackstrap molasses fed to mules has a higher value compared to corn than it has when fed to cattle.

STEER FEEDING EXPERIMENTS—1929-1931

In the fall of 1929 an experiment in feeding blackstrap molasses to steers was started at the Louisiana Station to obtain information on the value of blackstrap molasses in steer fattening rations with and without silage. Four lots of cattle were fed in 1929-30 and in 1930-31; two lots receiving molasses and two lots no molasses, each year. In addition four steers were fed in special stalls for the determination of the digestibility of molasses and its effect on the digestibility of a fattening ration.

The following tables give the weights, gains, and feed required per 100 pounds gain:

TABLE 1. MOLASSES AND CORN AND SOYBEAN SILAGE IN FATTENING RATIONS FOR YEARLING STEERS*

10 Steers per lot. October 25, 1929, to March 15, 1930—140 Days

	I	*II*	*III*	*IV*
Rations Fed	*Gr. Whole Ear Corn, C. S. Meal* *Hay*	*Gr. Whole Ear Corn, C. S. Meal Molasses* *Hay*	*Gr. Whole Ear Corn, C. S. Meal Silage* *Hay*	*Gr. Whole Ear Corn, Molasses* *C. S. Meal Silage, Hay*
Initial weight, lbs. ave.	428	431	430	426
Final weight, lbs. ave.	718	712	727	728
Daily gain, lbs. ave.	2.07	2.01	2.12	2.16
Daily feed, lbs.				
Gr. whole ear corn	9.26	6.14	9.30	6.15
Molasses	....	2.38	....	2.38
C. S. Meal	2.07	2.07	2.08	2.08
Hay	7.09	8.31	4.80	5.13
Silage	....	....	8.30	10.73
Feed required for 100 lbs. gain				
Gr. whole ear corn	447	306	438	286
Molasses	...	118	...	110
C. S. Meal	100	103	98	96
Hay	337	414	226	238
Silage	...	...	391	498
Feed cost per 100 lbs. gain	$10.23	$ 9.86	$10.44	$ 9.65

Flake salt available in all lots.

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*These would be classed as calves in northern feed lots.

In these tests the addition of molasses to fattening rations for steers decreased the cost of gains and slightly increased gains. Molasses was priced at $1.00 per 100 pounds or 11.7 cents per gallon. The molasses appeared to be worth around $25.00 per ton as a replacement for corn. The steers receiving molasses appeared to have better appetites and ate more hay and silage.

TABLE 2. MOLASSES AND CORN AND SOYBEAN SILAGE IN FATTENING RATIONS FOR YEARLING STEERS

October 15, 1930, to March 14, 1931—150 days. 10 Steers per lot.

Lot	*I*	*II*	*III*	*IV*
Rations Fed	*Gr. Whole Ear Corn, C. S. Meal Hay*	*Gr. Whole Ear Corn, C. S. Meal Molasses* *Hay*	*Gr. Whole Ear Corn, C. S. Meal Silage* *Hay*	*Gr. Whole Ear Corn, C. S. Meal Molasses* *Silage, Hay*
Initial weight, lbs. ave.	380	383	378	371
Final weight, lbs. ave.	658	662	643	642
Daily gain, lbs. ave.	1.85	1.86	1.77	1.81
Daily feed, lbs.				
Corn, ground whole ear	11.90	9.21	11.14	9.21
Molasses	.....	1.98	.....	1.95
Cottonseed meal	2.02	2.02	2.02	2.01
Hay, grass	2.10	3.43	1.43	2.79
Silage	....	....	1.30	1.65
Feed required per 100 lbs. gain				
Corn, ground whole ear	642	495	631	512
Molasses	...	106	...	108
Cottonseed meal	109	109	115	112
Hay, grass	113	184	80	155
Silage	...	...	73	91
Feed cost per 100 lbs. gain	$11.96	$11.28	$11.92	$11.65

Salt and mineral mixtures fed in all lots.

More complete data on this test is published in Louisiana Bulletin No. 266, Blackstrap Molasses and Corn-Soybean Silage For Fattening Steers; copies of which are available on request.

The addition of molasses to dry rations (not containing silage) had no significant effect upon the digestibility of crude protein, ether extract, or crude fiber. The digestibility of the nitrogen-free extract and the ash digestibility were increased.

Adding silage to a dry ration had no significant effect upon the digestibility of the nutrients except to lower the digestibility of the ether extract (fat).

The addition of molasses to silage rations lowered the digestibility of crude protein but increased the digestibility of carbohydrates, ether extract, and ash, and lowered the nitrogen balance, indicating a lowered utilization of nitrogen or protein.

FEEDING MOLASSES AND RICE BRAN TO YEARLINGS ON PASTURE

In the summer of 1931 two groups of mixed heifers and steers were fattened with grain on pasture. In one lot a mixture of approximately equal parts of rice bran and molasses was substituted for part of the corn and cottonseed meal in the ration. The gains were equal in each lot but it required 10% more feed to produce 100 pounds of gain in the rice bran-molasses ration mixture. The sale price was practically the same for the two lots and the net return after deducting the cost of feed was the same.

Table 3 gives the record of weights and gains, feed consumed per day and per 100 pounds gain, and record of sale.

TABLE 3. Molasses and Rice Bran in Rations for Fattening Yearlings on Pasture

March 14 to July 11, 1931—119 days.

Rations Fed	*Lot I* *Corn & Cotton seed Meal (Pounds)*	*Lot II* *Corn, CSM, Rice Bran, Molasses (Pounds)*
Average initial weight, pounds	418.5	418.5
Average final weight, pounds	605.0	606.0
Average total gain, pounds	186.5	188.7
Average daily gain, pounds	1.57	1.59
Average daily ration:		
Corn—ground ear, pounds	1.87	1.51
Corn—shelled, pounds	1.09	.74
Rice bran, pounds	....	.74
Cottonseed meal, pounds	1.35	1.00
Molasses, pounds	....	.83
Total	4.31	4.82
Feed per 100 pounds gain:		
Corn—ground ear, pounds, shelled basis	119.7	95.8
Corn—shelled, pounds	70.0	46.5
Rice Bran, pounds	.....	46.5
Cottonseed meal, pounds	86.4	62.7
Molasses, pounds	.....	52.4
Total	276.1	303.9
Financial Data		
Initial value at 5¢	$20.92	$20.93
Average sale weight, New Orleans	575.00	577.00
Sale price per 100 pounds	$5.42	$5.37
Average sale value	$31.20	$30.99
Average cost of feed	$6.08	$5.87
Selling cost	$3.00	$3.00
Total cost	$30.00	$29.80
Balance, excluding pasture	$1.20	$1.19

Ninety-eight pounds of molasses and rice bran replaced 71.4 pounds of corn and cottonseed meal. Assuming cottonseed meal to be equal to corn, and rice bran 68% the value of corn for fattening cattle, the molasses had a replacement value of 76.3%.

FEEDING BLACKSTRAP MOLASSES AND A MIXTURE OF BLACKSTRAP MOLASSES AND SUGAR CANE BAGASSE IN COMPARISON WITH CORN AND RICE BRAN FOR FATTENING STEERS—1936–37

C. I. Bray and A. L. Rhoad*

This experiment was conducted at the Iberia Livestock Experiment Farm at Jeanerette, Louisiana in cooperation with the United States Department of Agriculture.

Cattle Used

The steers used were some that had been cut back out of a group of grade Herefords used in summer grazing tests. The best steers were shipped to New Orleans for slaughter at the end of summer grazing. The twenty-three remaining steers were not ready for market. They were valued by a representative of the New Orleans Stock Yards at one cent less per pound than those which were shipped. The steers retained for feeding averaged around 950 to 970 pounds in weight.

Plan of Experiment

The basal ration used in this test was an equal mixture of corn, and rice-bran fed with four pounds of cottonseed meal and with rice straw as the sole roughage. Lot I received this ration. In Lot II, six pounds of blackstrap molasses was substituted for six pounds of corn and rice bran. In Lot III, ten pounds of a bagasse-molasses mixture, containing six pounds of molasses, was substituted for six pounds of the corn and rice bran mixture. The rations after the steers reached full feed were as given below:

	Lot I	*Lot II*	*Lot III*
		Average feed per steer	
	Lbs.	*Lbs.*	*Lbs.*
Corn	7½	4½	4½
Rice bran	7½	4½	4½
Cottonseed meal	4	4	4
Blackstrap molasses	0	6	0
Bagasse-molasses	0	0	10
Rice straw	Unlimited	Unlimited	Unlimited

The steers were on feed for 84 days and were started on five pounds

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of concentrates per day, which was gradually increased until a full feed of 19 pounds of concentrates was reached at the end of six weeks. These amounts were all the steers in Lot I and Lot III would eat, but the molasses lot (Lot II) would probably have eaten a little more feed.

TABLE 4. FATTENING STEERS ON CORN, RICE BRAN, COTTONSEED MEAL, BLACKSTRAP MOLASSES AND A BAGASSE-MOLASSES MIXED FEED

Feeding period—December 16, 1936—March 10, 1937—84 days.

Lot number	*I*	*II*	*III*
Number of steers in lot	8	8	7
Ration	*Corn, rice bran, cottenseed meal, rice straw*	*Corn, rice bran, c.s. meal, molasses, rice straw*	*Corn, rice bran molasses-bagasse, c.s. meal, rice straw*
	Pounds	*Pounds*	*Pounds*
Average initial weight	941.5	957	973.4
Average final weight	1057.6	1087.2	1113.7
Average gain	116.1	130.2	140.3
Average daily gain	1.38	1.55	1.67
Average daily feed per steer			
Corn	5.5	3.14	3.14
Rice bran	5.5	3.14	3.14
Cottonseed meal	3.32	3.32	3.32
Molasses	....	4.78	....
Bagasse-molasses	....	....	8.1
Rice straw	14.9	17.1	12.2
Feed per 100 lbs. gain			
Corn	398.1	202.5	189.6
Rice Bran	398.1	202.5	189.6
Cottonseed meal	240.1	214.1	200.5
Molasses	.....	308.1	...
Bagasse-molasses	.....	.....	489.7
Rice straw	1077.5	1104.5	738.1
Feed cost per 100 lbs. gain	$19.87	$14.35	$15.54

Cost of feeds: Corn, per ton—$45.00; rice bran, per ton—$27.00; cottonseed meal, per ton—$38.90; bagasse-molasses, per ton—$18.00; molasses, per gal.—$0.08; molasses, per ton—$13.67.

Table 4 gives the record of weights and gains, feed consumed per day, and feed per 100 pounds gain. The gains were somewhat low considering the size of the cattle and the ration fed. The cattle were fed rice straw as roughage and consumed from 12 to 17 pounds per day. They did not receive any alfalfa hay as in the experiments at Lake Charles, which may have been the cause of reduced gains the last month of feeding. In this test Lot II, receiving blackstrap molasses, made higher gains at less cost than Lot I fed the check ration. Lot III fed the molasses-bagasse mixture made still better gains, but cost slightly more to feed and made less profit.

MARKETING DATA

The cattle were shipped to Fort Worth and sold March 15, 1937. Table 5 gives the marketing data in detail.

TABLE 5. MARKETING DATA

Lot number *Number of steers in lot*	*I* 8	*II* 8	*III* 7
Ration	*No molasses*	*Molasses*	*Bagasse-molasses*
Ave. feed-lot weight, at farm, pounds	1057.5	1087.3	1113.7
Ave. market weight, Fort Worth, pounds	1005	1036.2	1048
Shipping shrink, pounds	52.5	51.1	65.7
Per-cent shrink	5.0	4.7	5.9
Ave. dressed weight, pounds	534.7	599.0	603.6
Dressing percentage	58.1	57.8	57.6
Sale price per 100 lbs.	$8.00	$8.12	$7.96*
Sale value per head	80.40	84.19	83.45
Sale cost per head	5.48	5.48	5.48
Net sale value	74.92	78.71	77.97
Net sale price per pound	7.45	7.60	7.44
Estimated feeder value at 5c per lb.**	47.07	47.85	48.65
Feed cost per steer	23.07	18.68	21.81
Total cost	$70.14	$66.53	$70.46
Net sale value	74.92	78.71	77.97
Balance	4.78	12.18	7.51

*One low priced steer brought the average down, otherwise this lot would have shown the highest average price.

The steers which had been sold in New Orleans off grass in the fall brought 5.2¢ per pound on the basis of pasture weights and these cut-backs would possibly have brought 4½¢ or less. The results have been calculated on a 5c basis.

There was little difference in either shrinkage or dressing percentage between the three lots, but this slight difference was in favor of the lot which received no molasses. The steers were valued and weighed individually at market and the average sale price obtained in this way. There was little material difference in sale price but one steer in Lot III (bagasse-molasses) sold for a lower price than the others which made the average for this lot a few cents less per 100 pounds.

Conclusions

1. The steers fed blackstrap molasses (Lot II) made practically as good gains as did the steers fed bagasse and molasses, and sold for a higher average market price. The financial returns on this lot were higher than for the other two lots, due to the low price of molasses. Molasses can apparently be fed economically up to six pounds per head per day to fattening steers of this weight. One pound of molasses replaced 1.32 pounds of mixed concentrates per unit of gain.

2. The steers on the bagasse-molasses mixture made much better gains during the first two months of the experiment, but during the last 28 days made rather low gains, although they appeared to be eating well and doing well. Because of this, Lot III ranked second in net proceeds.

Considering the bagasse only as roughage 196 pounds of bagasse replaced 339.4 pounds of rice straw. Two hundred and ninety-four pounds of molasses in the bagasse molasses mixture replaced 208.5 pounds of corn, 208.5 pounds of rice bran, and 39.6 pounds of cottonseed meal, or 456.6 pounds mixed feed, a ratio of 1 to 1.55.

If the bagasse was of value only as roughage, the molasses fed in this combination had a slightly higher value than when fed alone as in Lot II.

The cost of the bagasse molasses mixture was high in proportion to the local price of molasses. At $15.99 per ton, f.o.b. price for the bagasse-molasses feed mixture, and $3.00 per ton freight, the molasses in this mixture cost $30.00 per ton as compared to $13.67 per ton (8 cents per gallon) for local molasses.

3. Lot I receiving no molasses made the lowest gains and cost more per pound of gain.

4. The gains made during this experiment were unsatisfactory. All but two of the steers were found to have flukey livers when slaughtered. Several steers made very poor gains. This condition was not confined to any one lot, showing that the trouble was not due to any difference in the rations fed. It is probably that had some good green alfalfa been fed with the rice straw to supply Vitamin A the gains would have been better the last month of the test.

The returns from feeding were satisfactory on a feeder value of 5 cents per pound. On this basis the molasses fed steers (Lot II) made $12.18 per head, the bagasse-molasses steers (Lot III) $7.51 per head, and the no-molasses lot (Lot I) $4.78 per head.

RICE PRODUCTS AND BLACKSTRAP MOLASSES FOR FATTENING STEERS

In Cooperation With Swift and Co., Lake Charles

In 1938 Swift and Company at Lake Charles entered into a cooperative agreement with the Louisiana Agricultural Experiment Station to conduct feeding experiments and pasture experiments at the Lake Charles plant. Swift and Company supplied a feeding barn equipped with six feed lots and provided the cattle and feed for experimental work, with the experiment station providing the labor and supervision. The work was originally planned and in charge of Dr. M. G. Snell, Assistant Professor in Animal Industry who remained in charge until February 1941 when he entered military service. F. L. Morrison had immediate charge of the work until November 1940 when he left on military leave and was replaced by Murl Jackson.

The experiments were planned to compare various amounts of molasses replacing part of a rice bran, rice polish, cottonseed meal ration fed with rice straw. The molasses was fed at the following rates—12½%, 25%, 37½% and 50% of the concentrate. One lot was fed a ration of corn, cottonseed meal and rice straw as an additional check lot.

Experiment I—1939

Feeding Different Amounts of Molasses to Fattening Steers With Rice By-Products and Cottonseed Meal

CATTLE USED

The cattle used were grade Aberdeen-Angus steers weighing approximately 506 pounds, divided into six lots of ten each.

ROUGHAGE AND MINERALS

Rice straw was fed as roughage, supplemented by a small amount of good green alfalfa hay fed once every two weeks to supply Vitamin A, and also supplemented by 1/10 of a pound of powdered oystershell per day per steer, mixed with the concentrate ration to supply calcium. Salt was provided in all lots at all times.

CONCENTRATE RATIONS

Lot 1. Corn,[12] cottonseed meal.[4]
Lot 2. Rice bran,[6] rice polish,[6] cottonseed meal.[4]
Lot 3. Rice bran,[5] rice polish,[5] molasses,[2] cottonseed meal.[4]
Lot 4. Rice bran,[4] rice polish,[4] molasses,[4] cottonseed meal.[4]
Lot 5. Rice bran,[3] rice polish,[3] molasses,[6] cottonseed meal.[4]
Lot 6. Rice bran,[2] rice polish,[2] molasses,[8] cottonseed meal.[4]

RESULTS

Table 6 gives the record of weights and gains for each lot, average daily rations, and feed required to produce 100 pounds gain.

SLAUGHTER DATA

Table 7 gives the slaughter data including dressing percent, average carcass grade and slaughter value per 100 weight based on carcass values.

TABLE 6. RICE PRODUCTS AND MOLASSES FOR FATTENING CATTLE

10 steers per lot—March 23 to July 13, 1939—112 days

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Averages in pounds per steer						
Initial weight	505	506	507	513	505	504
Final weight	817	773	773	772	780	784
Gain	312	267	266	259	275	280
Daily gain	2.78	2.38	2.37	2.31	2.45	2.50
Average daily ration						
Corn	14.00	...	...	...	...	...
Rice bran	...	7.00	5.83	4.67	3.50	2.33
Rice polish	...	7.00	5.83	4.67	3.50	2.33
Molasses	...	...	2.33	4.67	7.00	9.33
Cottonseed meal	4.67	4.67	4.67	4.67	4.67	4.67
Total concentrates	18.67	18.67	18.67	18.67	18.67	18.67
Alfalfa hay	.20	.20	.20	.20	.20	.20
Rice straw	4.93	4.74	4.92	5.72	5.45	5.75
Total roughage	5.13	4.94	5.12	5.95	5.65	5.95
Feed consumed per cwt. gain						
Corn	503	...	...	...	...	...
Rice bran	...	294	246	202	143	93
Rice polish	...	294	246	202	143	93
Molasses	...	...	98	202	285	373
Cottonseed meal	168	196	197	202	190	187
Total concentrates	671	784	786	808	761	746

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TABLE 6. Rice Products and Molasses For Fattening Cattle—(*continued*)

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Alfalfa hay	7	8	8	10	8	8
Rice straw	177	199	208	247	222	230
Total roughage	184	207	216	257	230	238
Feed cost per cwt. gain	$10.60	$10.80	$10.72	$10.60	$ 9.47	$ 8.85
Cost per feeder steer	30.34	30.37	30.40	30.79	30.30	30.25
Feed cost per steer	33.21	28.78	28.49	24.68	26.02	24.79
Total cost	66.35	61.95	61.69	58.27	59.12	54.84
Selling price per cwt.	8.46	8.00	7.98	8.12	7.98	7.88
Sale value per steer	69.14	61.82	61.65	62.69	62.23	61.80
Profit or loss	2.79	—.13	—.04	4.42	3.11	6.96

Feed prices per cwt.: Ground corn—$1.47; Rice bran—$1.10; Rice polish—$1.41; Blackstrap molasses—$.74; Cottonseed meal—$1.50; Alfalfa hay—$1.23; Rice straw—$.36; Salt—$.49.

TABLE 7. Sale Value, Dressing Percent, and Carcass Grades

Lot	Ration	*Average Daily gain*	*Dressing Percent*	*Carcass Grade ave.**	*Slaughter Value per cwt.***
1	Corn (Check)	2.78	56.9	13.6	$8.46
2	Rice Bran Rice Polish	2.38	55.4	14.1	8.00
3	Rice Bran Rice Polish Molasses 12.5%	2.37	55.4	14.1	7.98
4	Rice Bran Rice Polish Molasses 25%	2.31	55.6	13.9	8.12
5	Rice Bran Rice Polish Molasses 37.5%	2.45	55.8	14.2	7.97
6	Rice Bran Rice Polish Molasses 50%	2.50	55.0	14.2	7.88

*Swift steer grades are as follows: 13—select, 14—Swift, 15—Sanco.
**Based on carcass values.

The corn fed lot (Lot 1) made the best gains and had the highest sale value. However, the lots fed the larger amounts of molasses made slightly higher profits due to the low price of molasses.

It was estimated from this experiment that molasses had 80 to 90 per cent the feeding value of corn, and that the mixture of rice bran and polish had about 82 per cent the feeding value of corn.

Since the results have varied only slightly from year to year a complete discussion of the value of these rations is given on page 36 following the record of the three tests.

Experiment II—1940

Varying Proportions of Molasses Fed to Fattening Steers With Rice Bran, Rice Polish and Cottonseed Meal in Comparison with Corn and Cottonseed Meal.

CATTLE USED

Sixty-six grade Aberdeen-Angus steers weighing approximately 445 pounds were divided into six lots of 11 steers each; fed for a period of 112 days.

RATIONS AND ROUGHAGE

Rations fed and the methods of feeding were the same as in the 1939 experiment.

TABLE 8. Rice Products and Molasses for Fattening Cattle

11 steers per lot—February 7 to May 29, 1940—112 days

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Average in pounds per steer						
Initial weight	443	443	443	447	447	443
Final weight	743	722	729	740	713	720
Gain	300	279	286	293	266	277
Daily gain	2.68	2.49	2.55	2.62	2.38	2.47
Average daily ration						
Corn	13.37	...	...	...	...	...
Rice bran	...	6.68	5.57	4.46	3.34	2.23
Rice polish	...	6.68	5.57	4.46	3.34	2.23
Molasses	...	...	2.23	4.45	6.69	8.91
Cottonseed meal	4.45	4.45	4.45	4.45	4.45	4.45
Total concentrates	17.82	17.81	17.82	17.82	17.82	17.82
Alfalfa hay	.2	.2	.2	.2	.2	.2
Rice straw	3.05	4.03	4.49	4.60	4.84	5.21
Total roughage	3.25	4.23	4.69	4.80	5.04	5.41
Feed consumed per cwt. gain						
Corn	499.1	...	...	...	...	...
Rice bran	...	268.0	218.3	169.9	140.6	90.4
Rice polish	...	268.0	218.3	169.9	140.6	90.4
Molasses	...	...	87.4	169.9	281.3	361.6
Cottonseed meal	216.4	179.1	174.6	169.9	187.6	180.7
Total concentrates	665.5	715.1	698.6	679.6	750.1	723.0

TABLE 8. RICE PRODUCTS AND MOLASSES FOR FATTENING CATTLE—(*continued*)

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Alfalfa hay	7.5	8.0	7.9	7.7	8.5	8.2
Rice straw	114.15	161.8	176.1	175.8	203.7	211.4
Total roughage	121.65	169.8	184.0	183.5	212.2	219.6
Feed cost per cwt. gain	$12.05	$10.90	$10.34	$ 9.72	$10.36	$ 9.66
Feed cost per steer	36.15	30.40	29.53	28.55	27.57	26.67
Cost per feeder steer	26.93	26.93	26.93	27.18	27.18	26.93
Total cost	63.08	57.33	56.46	55.73	54.75	53.60
Selling price per cwt.	8.78	7.83	8.19	7.67	7.83	7.49
Sale value per steer	65.24	56.53	59.71	56.76	55.83	53.93
Profit or loss	2.16	—.80	3.25	1.03	1.08	.33

Feed prices per cwt.: Corn chops—$1.69, Rice bran—$1.08, Rice polish—$1.49, Molasses—$.87, Cottonseed meal—$1.91, Alfalfa hay—$.90, Rice straw—$.30, Salt—$1.14, Oystershell—$.70.

RESULTS

Table 8 gives the record of weights and gains for each lot, average daily rations and feed required to produce 100 pounds gain. The sale prices per cwt. were approximately the same as in 1939; ranging from $7.49 to $8.78 per 100 pounds, but since the prices of feed had increased considerably the profits were not as high. The corn lot, Lot 1, again made the highest daily gains, but only slightly higher than Lot 4, receiving 25% molasses. Lot 3, fed 12.5% molasses showed a slightly higher profit than the corn-fed lot, but ranked second in slaughter value and in dressing percentage. The lot receiving rice products without molasses (Lot 2) showed a slight loss. The differences in gains were not very marked and there were no great variations between the molasses fed lots.

SLAUGHTER DATA

Table 9 gives the slaughter data, including dressing percent, carcass grade, and slaughter value per 100 weight based on carcass dress-out values.

TABLE 9. COMPARISON OF VALUE AND DRESSING PERCENT OF CATTLE FED DIFFERENT RATIONS

Lot	*Ration*	*Average Daily grain*	*Dressing percent*	*Carcass Grade ave.**	*Slaughter Value per cwt.***
1	Corn (Check)	2.68	59.7	13.8	$8.78
2	Rice Bran Rice Polish	2.49	55.4	14.4	7.83
3	Rice Bran Rice Polish Molasses 12.5%	2.55	55.8	14.0	8.19
4	Rice Bran Rice Polish Molasses 25%	2.62	54.2	14.4	7.67
5	Rice Bran Rice Polish Molasses 37.5%	2.38	56.0	14.4	7.83
6	Rice Bran Rice Polish Molasses 50%	2.49	55.9	14.5	7.49

*Swift steer grades are as follows: 13—select, 14—Swift, 15—Sanco.
**Based on carcass values.

Experiment III—1941

Varying Proportions of Molasses Fed with Rice Bran, Rice Polish and Cottonseed Meal

This experiment was a repetition of the two previous tests. A summary of results is given in Table 10. The corn and cottonseed meal

TABLE 10. Rice Products and Molasses for Fattening Cattle

10 steers per lot—January 5 to April 29, 1941—112 days.

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice. Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Averages in pounds per steer						
Initial weight	536	535	532	536	541	542
Final weight	811	719	725	777	753	764
Gain	275	184	193	241	212	222
Daily gain	2.45	1.64	1.72	2.15	1.89	1.97
Average daily ration						
Corn	11.48	...	...	...	...	...
Rice bran	...	5.73	4.81	3.82	2.86	1.92
Rice polish	...	5.73	4.81	3.82	2.86	1.92
Molasses	...	...	1.92	3.82	5.75	7.65
Cottonseed meal	3.82	3.82	3.82	3.82	3.82	3.82
Total concentrates	15.3	15.3	15.3	15.3	15.3	15.3
Alfalfa hay	.2	.2	.2	.2	.2	.2
Rice straw	4.47	4.30	4.58	4.78	4.50	4.47
Total roughage	4.67	4.50	4.78	4.98	4.70	4.67
Feed consumed per cwt. gain						
Corn	468.7	...	...	...	...	...
Rice bran	...	350.3	278.5	178	151.8	97
Rice polish	...	350.3	278.5	178	151.8	97
Molasses	...	...	111.3	178	303.9	388
Cottonseed meal	156.3	233.4	222.7	178	202.5	194
Total concentrates	625.0	934	891	712	810	776

TABLE 10. RICE PRODUCTS AND MOLASSES FOR FATTENING CATTLE—(*continued*)

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4	Rice Bran 6 Rice Pol. 6 C. S. Meal 4	Rice Bran 5 Rice Pol. 5 Molasses 2 C. S. Meal 4	Rice Bran 4 Rice Pol. 4 Molasses 4 C. S. Meal 4	Rice Bran 3 Rice Pol. 3 Molasses 6 C. S. Meal 4	Rice Bran 2 Rice Pol. 2 Molasses 8 C. S. Meal 4
Alfalfa hay	8.1	12.1	11.6	9.2	10.5	10.1
Rice straw	182.4	262.2	265.8	221.6	238.3	226.0
Total roughage	190.5	274.3	277.4	230.8	248.8	236.1
Feed cost per cwt. gain	$ 9.79	$11.82	$11.13	$ 8.78	$ 9.81	$ 9.24
Feed cost per steer	26.92	21.71	21.47	21.20	20.80	20.47
Cost per feeder steer	33.38	33.30	33.12	33.38	33.68	33.74
Total cost	60.30	55.01	54.59	54.58	54.48	54.21
Selling price per cwt.	8.45	7.65	7.95	7.85	7.85	8.00
Sale value per steer	66.58	52.93	57.63	59.18	57|30	59.36
Profit or loss	6.28	—2.08	3.04	4.60	2.82	5.15

Feed prices per cwt.: Corn—$1.45; Rice bran—$.85, Rice polish—$1.25, Molasses—$.90, Cottonseed meal—$1.55, Alfalfa hay—$1.13, Rice straw—$.25, Salt—$.40, Oystershell—$.60.

ration made the largest gains and the greatest profits. The second highest gains were made by Lot 4 fed four pounds of molasses daily, but Lot 6 fed eight pounds of molasses made a greater profit. The only lot which did not show a profit over feed costs was Lot 2, receiving rice bran and rice polish without molasses. At 60 cents per cwt. for molasses, which was the usual prewar price, Lot 6 receiving a 50% molasses ration would have made as good a profit as the corn lot.

The slaughter record, dressing percentage, carcass grade, and slaughter value per 100 pounds weight are given in Table 11. In this test the lot receiving 50% molasses (Lot 6) made the second highest slaughter value and the third highest dressing percentage.

TABLE 11. Comparison of Value and Dressing Percent of Cattle Fed Different Rations

Lot	*Ration*	*Average Daily grain*	*Dressing percent*	*Carcass Grade ave.**	*Slaughter Value per cwt.***
1	Corn (Check)	2.45	56.5	14.4	$8.45
2	Rice Bran Rice polish	1.64	53.9	15.7	7.65
3	Rice Bran Rice Polish Molasses 12.5%	1.72	53.1	14.4	7.95
4	Rice Bran Rice Polish Molasses 25%	2.15	54.6	14.8	7.85
5	Rice Bran Rice Polish Molasses 37.5%	1.89	54.8	15.2	7.85
6	Rice Bran Rice Polish Molasses 50%	1.99	54.7	14.8	8.00

*Swift steer grades are as follows: 13—select, 14—Swift, 15—Sanco.
**Based on carcass values.

Summary of Three Years Experiments*

Table 12 gives the three-year average for the experiment. Very little difference is shown between the four levels of molasses feeding. The corn and cottonseed meal lot (Lot 1) ranked first throughout the experiment both in profits and daily gains, while the lot receiving rice bran, rice polish without molasses was consistently lowest.

Of the four molasses-fed lots, the group fed 25% molasses showed a slightly higher average gain, due largely to a high gain in 1941. The lot fed 50% molasses showed a slightly greater profit than the other molasses-fed lots. Lot 3, fed two pounds molasses (12.5%), ranked only slightly ahead of Lot 5 fed six pounds (37.5%) molasses.

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*Mrs. Aldina S. Gates, graduate student in Animal Industry rendered valuable assistance in working up the records of the three tests and calculating the three-year averages.

TABLE 12. Average Results of Three Feeding Trials, 1939-1941

Average feeding period 112 days

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4 Rice Straw	Rice Bran 6 Rice Pol. 6 C. S. Meal 4 Rice Straw	Rice Bran 5 Rice Pol. 5 C. S. Meal 4 Molasses 2 Rice Straw	Rice Bran 4 Rice. Pol. 4 C. S. Meal 4 Molasses 4 Rice Straw	Rice Bran 3 Rice Pol. 3 C. S. Meal 4 Molasses 6 Rice Straw	Rice Bran 2 Rice Pol. 2 C. S. Meal 4 Molasses 8 Rice Straw
Averages in pounds per steer						
Initial weight	493	493.3	492.5	496.6	496.3	495
Final weight	789	737.6	747.9	762.0	747.7	754.7
Gain	296	244.3	255.4	265.4	251.4	259.7
Daily gain	2.64	2.18	2.28	2.37	2.24	2.32
Average daily ration						
Corn or rice products	12.95	12.95	10.80	8.63	6.48	4.30
Cottonseed meal	4.31	4.31	4.31	4.31	4.31	4.31
Molasses	...	...	2.15	4.31	6.47	8.65
Alfalfa hay	.2	.2	.2	.2	.2	.2
Rice straw	4.15	4.35	4.66	5.03	4.94	5.14
Feed consumed per cwt. gain						
Corn	490.1	...	...	...	...	...
Rice polish	...	303.4	247.5	183.3	145.1	93.5
Rice bran	...	303.4	247.5	183.3	145.1	93.5
Cottonseed meal	163.3	202.8	198.0	183.3	193.4	187.0
Molasses	...	...	99.0	183.3	290.2	374.0
Alfalfa hay	7.5	9.4	9.2	8.9	9.0	8.8
Rice straw	157.8	207.7	216.4	210.8	221.4	222.4

TABLE 12. AVERAGE RESULTS OF THREE FEEDING TRIALS, 1939-1941—(*continued*)

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 4 Rice Straw	Rice Bran 6 Rice Pol. 6 C. S. Meal 4 Rice Straw	Rice Bran 5 Rice Pol. 5 C. S. Meal 4 Molasses 2 Rice Straw	Rice Bran 4 Rice Pol. 4 C. S. Meal 4 Molasses 4 Rice Straw	Rice Bran 3 Rice Pol. 3 C. S. Meal 4 Molasses 6 Rice Straw	Rice Bran 2 Rice Pol. 2 C. S. Meal 4 Molasses 8 Rice Straw
Feed cost per cwt. gain	$10.81	$11.17	$10.73	$ 9.70	$ 9.88	$ 9.25
Feed cost per steer	32.09	26.96	26.49	25.72	24.79	23.97
Cost per feeder steer	30.09	30.09	30.04	30.29	30.27	30.19
Total cost	62.18	57.05	56.53	56.01	55.06	54.16
Selling price per cwt.	8.59	7.83	8.04	7.89	7.90	7.81
Sale value per steer	67.84	57.78	60.13	60.17	59.08	58.96
Profit or loss	5.66	.73	3.59	4.16	4.02	4.80

Feed prices per cwt.: Corn—$1.54, Rice bran—$1.01, Rice polish—$1.38, Cottonseed meal—$1.65, Molasses—$.84, Alfalfa hay—$1.08, Rice straw—$.30, Oystershell—$.60, Salt—$.68.

Table 13 gives the slaughter data for the three years, including dressing percentage, carcass grade and slaughter value per 100 weight.

TABLE 13. THREE YEAR AVERAGE OF DAILY GAINS, DRESSING PERCENTAGE, SALE VALUE PER 100 POUNDS, AND CARCASS GRADES 1939-41

Lot	*Ration*	*Average Daily grain*	*Dressing percent*	*Carcass Grade ave.**	*Slaughter Value per cwt.***
1	Corn	2.64	57.7	13.9	$8.59
2	Rice Bran Rice Polish	2.18	54.9	14.7	7.83
3	Rice Bran Rice Polish Molasses 12.5%	2.28	54.7	14.1	8.04
4	Rice Bran Rice Polish Molasses 25%	2.37	54.8	14.3	7.89
5	Rice Bran Rice Polish Molasses 37.5%	2.24	55.5	14.6	7.90
6	Rice Bran Rice Polish Molasses 50%	2.32	55.2	14.5	7.81

*Swift steer grades are as follows: 13—select, 14—Swift, 15—Sanco.
**Based on carcass values.

Summary of Results

1. The ration of corn, cottonseed meal and rice straw with a small amount of alfalfa hay to supply Vitamin A has produced higher gains each year and made the greatest profits ($5.66 per steer, not including labor).
2. No great differences resulted from feeding either 12.5%, 25%, 37.5% or 50% blackstrap molasses in the concentrate ration together with bran and rice polish and cottonseed meal. Feeding 8 pounds molasses (50%) made the best profits ($4.80 per steer), second only to the corn ration.
3. The steers fed 4 pounds of molasses (Lot 4) made slightly higher gains than Lot 6 receiving 8 pounds molasses and made the third highest profit ($4.16 per steer in the three-year test).
4. Steers fed rice products (bran and polish mixed) and cottonseed meal, without either corn or molasses as carbonaceous concentrates made the lowest gains and the least profit. Compared to Lot 1, fed corn and cottonseed meal, the rice products showed a value of 74% to 75% that of corn. Since this ration was not well balanced in respect to carbohydrates these percentage values are probably too low.
5. Feeding molasses at different levels shows considerable uniformity in

regard to the feeding value of the molasses. The following table, based on the feed requirements in Table 12 shows the amount of rice products and cottonseed meal replaced by 100 pounds of molasses, in the four molasses-fed lots. With the exception of Lot 4, which received 4 pounds of molasses per head per day, the replacement value of molasses was remarkably uniform; there being practically no difference in replacement value per pound when feeding either 2, 6, or 8 pounds per day.

TABLE 14. Feed Replaced by 100 Pounds of Molasses When Fed in Different Amounts to Fattening Steers Compared to Lot 2, Fed No Molasses

		100 lbs. Molasses Replaced			
Lot Number	*Molasses Fed Per Day*	*Rice Products*	*Cotton-seed Meal*	*Rice Straw*	*Estimated Corn Equivalent*
3	2 lbs.	112.9	4.84	—8.8	89.4
4	4 "	132.2	10.8	—1.6	109.9
5	6 "	109.1	3.2	—4.7	85.0
6	8 "	112.3	4.22	—3.9	88.4

Based on following basis: Corn 100, cottonseed meal 100. rice products (½ rice bran—½ rice polish) 75, rice straw not considered.

Experiment—1941-42

Corn, Rice Products, Molasses, Legume Hay and Rice Straw for Fattening Steers

C. I. Bray and M. E. Jackson

In the fall of 1941 another series of experiments was planned following the conclusion of the first tests on feeding rice products (La. Bul. 389) and on molasses feeding (pages .....). War time conditions made it advisable to discontinue these feeding experiments at the end of the first year. Hay was fed in two lots, replacing rice straw. Some corn was fed in all lots.

The following is the list of rations fed in 1941-42:

Lot 1. Corn,^{12} cottonseed meal,^{3} rice straw.*
Lot 2. Corn,^{9} rice bran,^{3} cottonseed meal,^{3} rice straw.
Lot 3. Corn,^{9} rice polish,^{3} cottonseed meal,^{3} rice straw.
Lot 4. Corn,^{9} rice bran,^{3} cottonseed meal,^{3} legume hay.**
Lot 5. Corn,^{6} rice bran,^{3} cottonseed meal,^{3} molasses,^{3} rice straw.
Lot 6. Corn,^{6} rice bran,^{3} cottonseed meal,^{3} molasses,^{3} legume hay.

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*A small amount of good green alfalfa hay was fed weekly in all rice straw lots to supply Vitamin A.

**This hay was principally lespedeza mixed with some grass. When no more lespedeza could be located, alfalfa hay was substituted.

TABLE 15. CORN, RICE PRODUCTS AND MOLASSES FOR FATTENING STEERS

Feeding period—Dec. 1, 1941 to March 30, 1942—Some steers sold Feb.

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Bran 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Pol. 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Bran 3 Legume Hay	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Rice Straw	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Legume Hay
Steers per lot	10	10	10	10	8*	10
Average days per lot	112	108.5	112	112	108.5	112
Average weights						
Initial weight	529.5	550.0	525.3	511.5	565.6	528.6
Final weight	797.0	784.2	771.7	793.0	823.1	790.2
Gain	267.5	234.2	246.4	281.5	257.5	261.6
Daily gain	2.30	2.16	2.20	2.51	2.37	2.33
Average daily ration						
Corn	10.96	8.22	8.22	8.22	5.48	5.48
Cottonseed meal	2.74	2.74	2.74	2.74	2.74	2.74
Rice bran	...	2.74	...	2.74	2.74	2.74
Rice polish	...	...	2.74	...	...	...
Molasses	...	...	...	...	2.74	2.74
Total concentrates	13.70	13.70	13.70	13.70	13.70	13.70
Rice straw	5.24	5.39	5.69	.29	6.55	.39
Legume hay	.17	.17	.17	6.33	.17	6.96
Total roughage	6.41	5.56	5.86	6.62	6.72	7.35
Feed consumed per cwt. gain						
Corn	458.4	381.1	373.3	326.7	221.4	234.4
Cottonseed meal	114.6	127.0	124.4	108.9	110.7	117.2
Rice bran or rice polish	...	127.0	124.4	108.9	110.7	117.2
Molasses	...	...	...	...	110.7	117.2
Total concentrates	573.1	635.1	622.1	544.5	553.5	586.0

TABLE 15. CORN, RICE PRODUCTS AND MOLASSES FOR FATTENING STEERS—(*continued*)

Lot	1	2	3	4	5	6
Concentrate Ration	Corn 12 C. S. Meal 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Bran 3 Rice Straw	Corn 9 C. S. Meal 3 Rice Pol. 3 Rice Straw	Corn 9 C. E. Meal 3 Rice Bran 3 Legume Hay	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Rice Straw	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Legume Hay
Rice straw	219.5	249.9	258.6	11.6	276.3	16.8
Legume hay	7.1	8.0	7.7	252.1	7.4	298.0
Total roughage	226.6	257.9	266.3	263.7	283.7	314.8
Feed cost per cwt. gain	$11.72	$12.18	$12.51	$12.47	$11.00	$14.07
Feed cost per steer	31.37	28.54	30.83	35.11	28.32	36.81
Cost per feeder steer	45.00	45.03	44.65	44.83	48.07	44.93
Total cost	76.37	73.57	75.48	79.94	76.39	81.74
Selling price per cwt.	10.15	9.70	9.97	10.07	9.77	10.05
Sale value per steer	78.46	73.76	74.56	77.15	77.99	77.30
Profit or loss	2.09	.19	—.92	—2.79	1.60	—4.44

Feed prices per cwt.: Corn—$1.80, C. S. Meal—$2.20, Rice Bran—$1.14, Rice polish—$1.56, Molasses—$1.94, Rice straw—$.38, Lespedeza hay—$.95, Alfalfa hay—$1.43, Salt—$.50, Oystershell—$.50.

Two steers that failed to gain weight were removed from Lot 5 early in the test.

It was difficult to obtain a uniform group of steers, especially in regard to weight. Some of the steers were larger and in slightly better condition at the beginning of the test. The average weight was 535 pounds, but the range of weights was from 400 to 785 pounds. The heavier steers were finished and sold on February 23 and the lighter yearlings carried on until March 30. The record of weights and gains, average daily rations, and feed per 100 pounds gain is given in Table 15.

Results of Experiment

Feed prices were high due to war conditions and the cattle did not make much profit above feed costs. The amount of concentrates was less than that fed in previous years. Lot 4, receiving corn, cottonseed meal, rice bran, and legume hay made the highest gains followed by Lot 5, fed corn, cottonseed meal, rice bran and molasses with rice straw. The third best gains were made by Lot 6, fed corn, cottonseed meal, rice bran, molasses and legume hay. The fourth best gain was made by Lot 1, on a standard ration of corn, cottonseed meal and rice straw. Because of the high price of hay, the two lots receiving hay were fed at a loss. Molasses cost $1.94 per 100 pounds and the molasses lot which made the highest gains made a lower profit than Lot 1.

The record of slaughter, dressing percentage, carcass grades and sale values is given in Table 16.

TABLE 16. AVERAGE DAILY GAINS, DRESSING PERCENTAGES, CARCASS GRADES, AND SALE PRICES

Lot	*Ration*	*Average Daily gain*	*Dressing per cent*	*Carcass Grade ave.**	*Slaughter Value per cwt.***
1	Corn 12 C. S. Meal 3 Rice Straw	2.38	56.7	14.2	$10.15
2	Corn 9 C. S. Meal 3 Rice Bran 3 Rice Straw	2.16	55.4	14.8	9.70
3	Corn 9 C. S. Meal 3 Rice Polish 3 Rice Straw	2.20	55.8	14.4	9.97
4	Corn 9 C. S. Meal 3 Rice Bran 3 Legume Hay	2.51	56.9	14.3	10.07
5	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Rice Straw	2.37	55.4	14.3	9.77
6	Corn 6 C. S. Meal 3 Rice Bran 3 Molasses 3 Legume Hay	2.36	56.6	14.1	10.05

*Grades between 14.0 and 14.9 are "Good".
**Based on carcass value.

There was little difference between Lots 1, 4 and 6 in sale value and in dressing percentage; also little difference between the three poorer lots (2, 3 and 5). Rice polish was superior to rice bran as a supplement to the corn ration, but was less profitable on account of the higher price.

1. The substitution of 33% molasses for an equal amount of corn in a ration of corn, cottonseed meal, rice bran and rice straw increased gains and raised the selling price of the cattle as compared to Lot 2 fed no molasses. At pre-war prices for molasses this ration would have been the most profitable in the test.

2. A ration of corn, cottonseed meal, rice bran, molasses and rice straw (Lot 5) made slightly higher gains than the ration of corn, cottonseed meal and rice straw (Lot 1) but the sale price was lower for the Lot 5 steers. Considering the sale prices of the cattle, corn at $36.00 per ton was more economical than molasses at $38.80 per ton. At pre-war prices for molasses the molasses ration would have been much more economical.

3. Rice straw at 20¢ per bale supplemented with a small amount of good green alfalfa hay was a more economical roughage than legume hay when lespedeza and grass hay was selling at $19.00 per ton and alfalfa at $28.40 per ton. At $14.00 per ton for lespedeza and grass hay, which was the farm price in September, the hay fed lots would have shown a profit.

4. Rice bran was more economical at $22.80 per ton than rice polish at $31.20 per ton but the steers in Lot 2 receiving rice bran without molasses or legume hay made the lowest gains and sold for the lowest price per 100 pounds.

5. Molasses showed an apparently higher value with rice straw used as roughage than with a hay ration. (Lot 2 compared to Lot 5.) On the basis of one feeding test, it would not be safe to draw any definite conclusions on this point.

AMOUNT OF OTHER FEEDS APPARENTLY REPLACED BY 100 LBS. OF MOLASSES 1921-42

	Corn Lbs.	*Rice Products Lbs.*	*Cottonseed Meal Lbs.*	*Roughage Lbs.*
With rice straw as roughage				
Lot 2 compared to Lot 5.........	144.2	14.7	14.7	—23.5
With legume hay as roughage				
Lot 4 compared to Lot 6.........	78.7	—7.1	—7.1	—47.8

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AN ECONOMIC STUDY OF THE SWEET POTATO ENTERPRISE IN THE NORTH LOUISIANA UPLAND COTTON AREA IN 1943

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AN ECONOMIC STUDY OF THE SWEET POTATO ENTERPRISE IN THE NORTH LOUISIANA UPLAND COTTON AREA IN 1943

By

LEO J. FENSKE AND J. NORMAN EFFERSON[1]

INTRODUCTION

Sweet potatoes have been produced as a staple food crop on farms in the North Louisiana Upland Cotton Area for many years. Recently, sweet potato production for commercial purposes has developed to a limited extent and production capacity studies have indicated that the growing of sweet potatoes as a commercial enterprise or cash crop can be expanded still further in the hilly areas of the state. However, the most important commercial sweet potato areas of the state are the St. Landry Parish region, centered around Sunset, Church Point, and Opelousas; the Feliciana Parishes region, near St. Francisville; and the newly-established West Carroll Parish area in the vicinity of Oak Grove.

War demands for food resulted in a need for more sweet potatoes. Part of the larger acreage and production goal for this crop was assigned to Louisiana because of its desirable climate and soil for the production of sweet potatoes. In order to meet production goals in Louisiana some of the increase in acreage was allocated to areas outside of the old commercial producing sections, since sweet potato acreages in the more established producing areas in the state were approaching the upper limits when desirable rotations and the labor supply were considered. In addition, alternative crops to partially replace cotton continued to be desirable in the upland area of the state in order to provide a more diversified type of farming.

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[1] Bureau of Agricultural Economics and Louisiana Agricultural Experiment Station, respectively.

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Appreciation is also expressed for the cooperation and assistance received from the 46 farmers in Bienville and Claiborne Parishes who furnished the basic data on which this report is based.

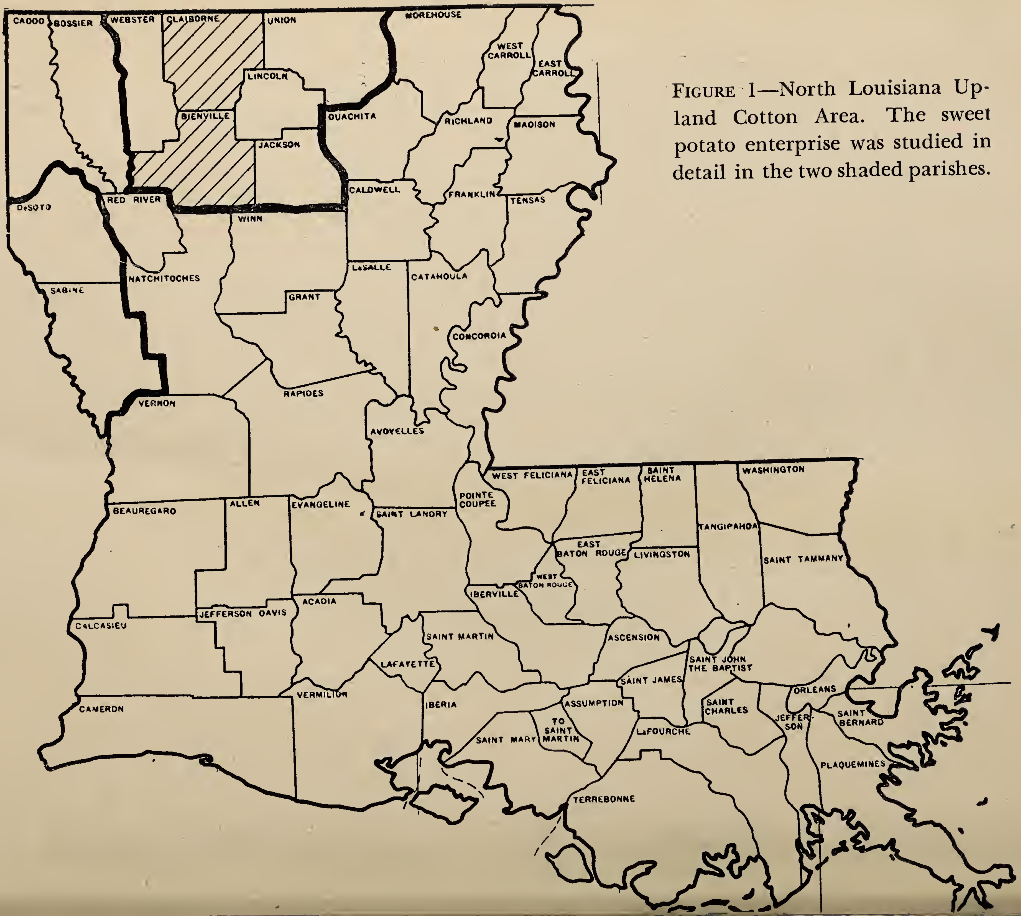

FIGURE 1—North Louisiana Upland Cotton Area. The sweet potato enterprise was studied in detail in the two shaded parishes.

This report presents an analysis of the experience of farmers in the production of sweet potatoes for commercial markets in 1943 in one of the upland regions of the state and analyzes the possibilities of growing the crop profitably in this region. The study was designed so that comparisons could be made betwen the prospective returns to be obtained from cotton, corn, peanuts, and sweet potatoes in the area under war-time and post-war conditions. The object of the report is to provide information that may be of assistance to farmers and professional agricultural workers in determining the place of the sweet potato enterprise in the North Louisiana Upland Cotton Area (Figure 1).

Source of Data

Detailed information on production practices, labor requirements, and costs and returns from the sweet potato enterprise was secured from approximately fifty farmers in Bienville and Claiborne Parishes in the fall of 1943. Yields and cost data were secured on the sweet potato crops harvested in 1943 and on average yields and costs over a period of years. In addition, similar data were secured on peanuts, cotton, and corn, which are the most important crop enterprises in the region, so as to have comparative information. All data collected were obtained from growers producing sweet potatoes for commercial markets.

Bienville and Claiborne Parishes are located in the North Louisiana Upland Cotton Area. This region is characterized by small family-type farms with cotton as the major cash crop. Other relatively important crops are corn, peanuts, sweet potatoes, cowpeas, vegetables, watermelons, and hay.

The topography of the area is rolling to hilly and some of the farm land is badly damaged by erosion. The soils are sandy and are fairly well adapted to both sweet potatoes and peanuts. Crop yields, in general, are relatively low compared to some other areas in the state.

Status of Sweet Potatoes in the Area

The federal census reports show a fluctuating sweet potato acreage in the North Louisiana Upland Cotton Area since 1899. The lowest acreage for any census year during the 1899-1939 period was in 1924, when 2,153 acres were harvested; the highest was in 1934, when 11,807 acres were reported (Table 1).

Estimates for 1943 indicate that approximately 15,100 acres of sweet potatoes were grown in the area. Four-fifths of this acreage was classified as production for farm food and feed and one-fifth was classified as production for commercial channels.

Although sweet potatoes are grown on most of the farms in the region, the average acreage per farm has been less than one acre. This indicates that sweet potatoes on a large proportion of the farms in the area are produced for home use only. In the region as a whole, sweet potatoes were grown on only 1.7 per cent of the total land used for

TABLE I. SWEET POTATO ACREAGE, PRODUCTION, AND YIELD PER ACRE, IN THE NORTH LOUISIANA UPLAND COTTON AREA, CENSUS YEARS 1899-1939.[1]

Year	*Acres Harvested Number*	*Total Production Bushels*	*Average Yield Per Acre Bushels*
1899	3,319	251,361	75.7
1909	7,905	618,992	78.3
1919	9,097	933,688	102.6
1924	2,153	84,459	39.2
1929	5,613	488,849	87.1
1934	11,807	458,579	38.8
1939	9,215	542,460	58.9

[1] Federal census reports, 1899-1940.

cultivated crops in 1942, while corn occupied 38.2 per cent of the cropland, and cotton 36.8 per cent. Peanuts were relatively more important than sweet potatoes, occupying 5.3 per cent of the total cropland acreage. The long-time average yield of sweet potatoes in the area is about seventy bushels per acre, with the reported yields in census years varying from a high point of 103 bushels per acre in 1919 to 39 bushels in 1924.

Because the survey in 1943 included commercial sweet potato crops only, the cropping system on the farms studied differed slightly from the usual situation. On the sample farms, sweet potatoes occupied about 7 per cent of the total cropland while peanuts were planted on only 2 per cent of the cropland area. Even on these farms, cotton and corn were the major crops and were of equal importance from an acreage standpoint.

The facts indicate sweet potatoes are relatively unimportant as a commercial crop in the North Louisiana Upland Cotton Area as a whole. In certain sections, like the Gibsland area in Bienville Parish, the crop is important as a source of cash income. Throughout the region, however, the soil and climatic conditions are favorable for the production of high quality sweet potatoes for the market. Thus, should cotton prices decline to the point that diversification in this region becomes even more important than at present, many farmers who now produce sweet potatoes for home consumption only might find it profitable to produce the crop on a commercial basis.

FARMER EXPERIENCE WITH THE SWEET POTATO ENTERPRISE IN THE NORTH LOUISIANA UPLAND COTTON AREA IN 1943

Sweet potato production on the farms studied was characterized by hand planting and half-row cultivating operations. The fields were relatively small, ranging in size from 1 to 16 acres, and averaging 4.2 acres per farm. Three large operators who were interviewed grew a total of 187 acres in 1943, but these unusual farms were not included in the general averages.

The long-time average rainfall for the area is about 50 inches; in 1943, however, the precipitation was only 39 inches. In April, early May, and June, rainfall in the region was less than the normal amount and as a result, the producers had some difficulty in getting sweet potato slips started at the proper time. Later in the summer of 1943, rainfall continued to be below normal, and as a result, the yields reported by the farmers interviewed for 1943 were somewhat lower than average yields over a long period of time.

LABOR REQUIREMENTS

The sweet potato enterprise requires relatively large amounts of man labor in comparison to other crop enterprises common to the region. Planting or setting and harvesting, usually hand operations, are the jobs requiring the largest number of man hours. Other important labor consuming jobs are slip production and seedbed preparation. The typical operations performed in the production of sweet potatoes in this area and the average number of hours required to do each job for the average one-horse operator and part-tractor operators are shown in Table 2. All cultivating operations were done with horses, even on the farms where tractors were used for some operations.

TABLE 2. MAN LABOR AND POWER REQUIREMENTS PER ACRE ON SWEET POTATOES, WHEN USING TYPICAL HORSE OPERATIONS AND PART TRACTOR OPERATIONS, BIENVILLE AND CLAIBORNE PARISHES

Operation	*Hours per acre*				
	Horse Operations		*Part tractor operations*		
	Man	*Horse*	*Man*	*Horse*	*Tractor*
Slip production	6.0	3.0	6.0	3.0	....
Seedbed preparation:					
Flat break	5.0	10.0	1.7	....	1.7
Bed up	2.0	4.0	0.7	....	0.7
Fertilize	2.0	2.0	2.0	2.0	....
Rebed	3.3	6.6	3.3	6.6	....
Harrow beds	1.4	1.4	1.4	1.4	....
Plant[1]	25.0	2.6	15.0	....	2.5
Cultivation:					
Sweep up[2]	6.7	6.7	6.7	6.7	....
Hoe	20.0	....	20.0	....	....
Lay by	3.3	3.3	3.3	3.3	....
Plow middles	2.0	2.0	2.0	2.0	....
Total preharvest	76.7	41.6	62.1	25.0	4.9
Harvest[3]	45.7	20.2	45.0	....	2.5
Total requirements[4]	122.4	61.8	107.1	25.0	7.4

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[1] Mechanical setter used with tractor.

[2] Two times during season.

[3] Includes vine cutting, digging, crating, and hauling to home storage house.

[4] Five hours of truck use per acre was used on tractor farms for hauling plants and hauling potatoes to storage.

Man labor requirements averaged 122 hours per acre under the usual production methods and 107 hours per acre for the operators using tractors for some of the heavy jobs. Hand planting required 25 man hours per acre as compared with 15 hours when using a tractor-drawn transplanter. In addition to requiring less man labor per acre for setting plants, the transplanting machine, which waters the plants during the setting operation, has the advantage that during dry seasons the crop can be planted more conveniently at the proper time instead of having to wait on a rain or go through with the time-consuming hand-watering operation.

When using horses or mule power only, about 62 workstock hours were required per acre of sweet potatoes produced. The operators using tractors for some of the operations average 25 horse hours and 7 tractor hours per acre.

Table 2 presents a detailed summary of the time requirements by the various operations. The facts indicate that further reductions in labor requirements can be obtained by a more complete mechanization of the various labor operations.

GROSS INCOME, COSTS, AND NET RETURNS

Table 3 summarizes the data collected on yields, prices received, materials used, and cash expenses per acre for sweet potatoes on the farms studied in 1943. This information is organized into three groups: the averages for all farms reporting, the averages for the 20 farms with highest yields of sweet potatoes, and the 20 farms with the lowest yields of sweet potatoes.

TABLE 3. GROSS INCOME, CASH EXPENSES, AND RETURNS OVER CASH EXPENSES PER ACRE OF SWEET POTATOES ON 40 FARMS CLASSIFIED BY YIELD PER ACRE BIENVILLE AND CLAIBORNE PARISHES, 1943

Item	*Unit*	*All farms*		*20 farms with highest yields*		*20 farms with lowest yields*	
		quantity	*value*	*quantity*	*value*	*quantity*	*value*
Production and income:							
Marketable	Bu.	70	$78.75	97	$109.13	44	$49.50
Other	Do.	33	16.50	44	22.00	20	10.00
Total[1]	Do.	103	$95.25	141	$131.13	64	$59.50
Materials used and expenses:							
Seed	Bu.	6	$ 9.00	7	$ 10.50	5	$ 7.50
Fertilizer	Lb.	290	5.31	385	6.93	240	4.45
Crates[2]	No.	40	2.50	63	3.15	27	2.11
Seed treating material		....	.20	....	.25	....	.15
Total		....	$17.01	....	$ 20.83	....	$14.21
Returns over cash expenses[3]		....	$78.24	....	$110.30	....	$45.29

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[1] Marketable at $1.125 per bushel; other at $0.50 per bushel.

[2] Crates for home storage; buyers furnished the balance. Charged at one-half their value for 1943 crop.

[3] This is the amount available to the operator for paying wages to himself and others, for use of workstock, equipment, land, and for other overhead expenses.

The yield of sweet potatoes on all farms reporting averaged 103 bushels per acre, of which 70 bushels per acre graded out as No. 1's or No. 2's and made up the production of marketable potatoes, and 33 bushels were classified as culls because of being oversize, undersize, cracked or cut, damaged by insects or diseases, or otherwise unfit to be included in the grades of marketable potatoes. These culls were used primarily as a feed for livestock.

The farmers survey reported that the relatively dry season which prevailed in 1943 had affected the yield per acre of sweet potatoes and that the average yields obtained for this season were below normal. The most common normal or long-time average yield per acre reported by the farmers interviewed was 100 bushels of marketable potatoes per acre.[2] Federal census reports and other related data show average yields per acre in this area to be lower than the data given above, but the farmers reporting in this study were commercial sweet potato growers and could be expected to obtain higher yields than the average of all farms.

Using prices that prevailed at digging time and shortly thereafter, the gross cash value of sweet potatoes averaged $95 per acre. The high-yield group produced an average of 97 bushels of marketable potatoes per acre with a gross value of $131 per acre and the low-yield group, 44 bushels per acre with a gross value of about $60.

Direct cash expenses amounted to $17 per acre on all farms, $21 per acre on the high-yield farms, and $14 per acre on the low-yield farms. Seed, fertilizer, and crates were the chief cash expenses. The operators obtaining high yields bedded more seed and used more fertilizer per acre, as is indicated in Table 3. For all farms, an average of about 300 pounds of fertilizer, mostly 4-12-4, was used; the operators obtaining high yields made an average application of 385 pounds per acre as compared with 240 pounds for the farmers in the low-yield group.

Marketing crates were usually furnished by the buyers. Nearly all producers, however, used crates for picking up potatoes, for storing seed, and for carrying over some potatoes for later sales. The growers estimated that the average life of the usual sweet potato crate was two seasons. Thus charging only one-half of the crate cost to the current crop, the average cash expenses for crates on the farms studied was $2.50 per acre.

Net returns after deducting all direct cash expenses averaged $78 per acre for all farms. The high-yield group averaged $110 per acre over cash expenses as compared with $45 per acre for the low-yield group.

COMPETITIVE POSITION OF SWEET POTATOES IN RELATION TO THE OTHER CROP ENTERPRISES IN THE AREA

Information as to costs, returns, labor requirements, and farm practices was obtained on the cotton, corn, and peanut enterprises from the same farmers who supplied the sweet potato data so that comparisons could be made between the sweet potato crop and the other important enterprises of the region. The need for other cash crops in addition to cotton in the area is fairly evident, and sweet potatoes may serve as one alternative.

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[2] "Bushel" and "crates" were used synonymously by farmers in this section, with the average weight per crate of sweet potatoes being 50 pounds; thus, throughout this report 1 bushel is considered to be 50 pounds of potatoes.

Cotton and corn yields in this area are relatively low when compared with yields in the more fertile sections of Louisiana. One-third to one-half bale of lint cotton per acre and 10 to 12 bushel corn yields are fairly common in the North Louisiana Upland Cotton Area. When prices are unfavorable, the net returns from cotton are very low.

Sweet potatoes and peanuts have been successfully grown in the region by farmers experienced in their production. The peanut crop is more profitable when produced on a relatively large scale with modern machinery. On the other hand, sweet potatoes are fairly well adapted to the small farm which is lacking in modern machinery. Both crops produce by-product feeds, peanut hay, and cull potatoes. The latter can be fed in the fresh form or dehydrated and converted into a concentrate feed of high feeding value.

Comparison of Labor Requirements for the Different Enterprises

In planning farming operations, the available labor supply must be balanced against the total labor requirements. Under the present shortage of labor, sweet potatoes are at a disadvantage because they have higher labor requirements than any of the other important crops in the region. Table 4 shows the average man and horse hours expended per acre on sweet potatoes, peanuts, cotton, and corn in the area studied.

Sweet potatoes averaged approximately 122 man hours per acre as compared with 83 hours for cotton, 55 for peanuts, and 33 for corn. Four and one-half acres of peanuts or three acres of cotton could be

Table 4. Average Labor Requirements Per Acre For Sweet Potatoes, Peanuts, Cotton, and Corn, Bienville and Claiborne Parishes, 1943

Operation	*Hours Per Acre*							
	Sweet Potatoes		*Peanuts*		*Cotton*		*Corn*	
	Man	*Horse*	*Man*	*Horse*	*Man*	*Horse*	*Man*	*Horse*
Preharvest:								
Slip production	6.0	3.0	....	....	....	....	....	....
Soil preparation	13.7	24.0	9.0	15.8	12.2	19.9	9.0[1]	13.5
Plant	25.0	2.6	1.9	1.9	2.0	2.0	2.0	2.0
Cultivate	12.0	12.0	12.1	12.1	14.2	14.2	11.2	11.2
Hoe	20.0	....	5.5	....	15.8	....	4.8	....
Total preharvest	76.7	41.6	28.5	29.8	44.2	36.1	27.0	26.7
Harvest	45.7	20.2	26.1[2]	5.8	38.7	3.4	5.4	3.6
Total	122.4	61.8	54.6	35.6	82.9	39.5	32.7	30.3

[1] Includes time spent in side-dressing with fertilizer.
[2] Includes 2.4 hours provided by picker operator.

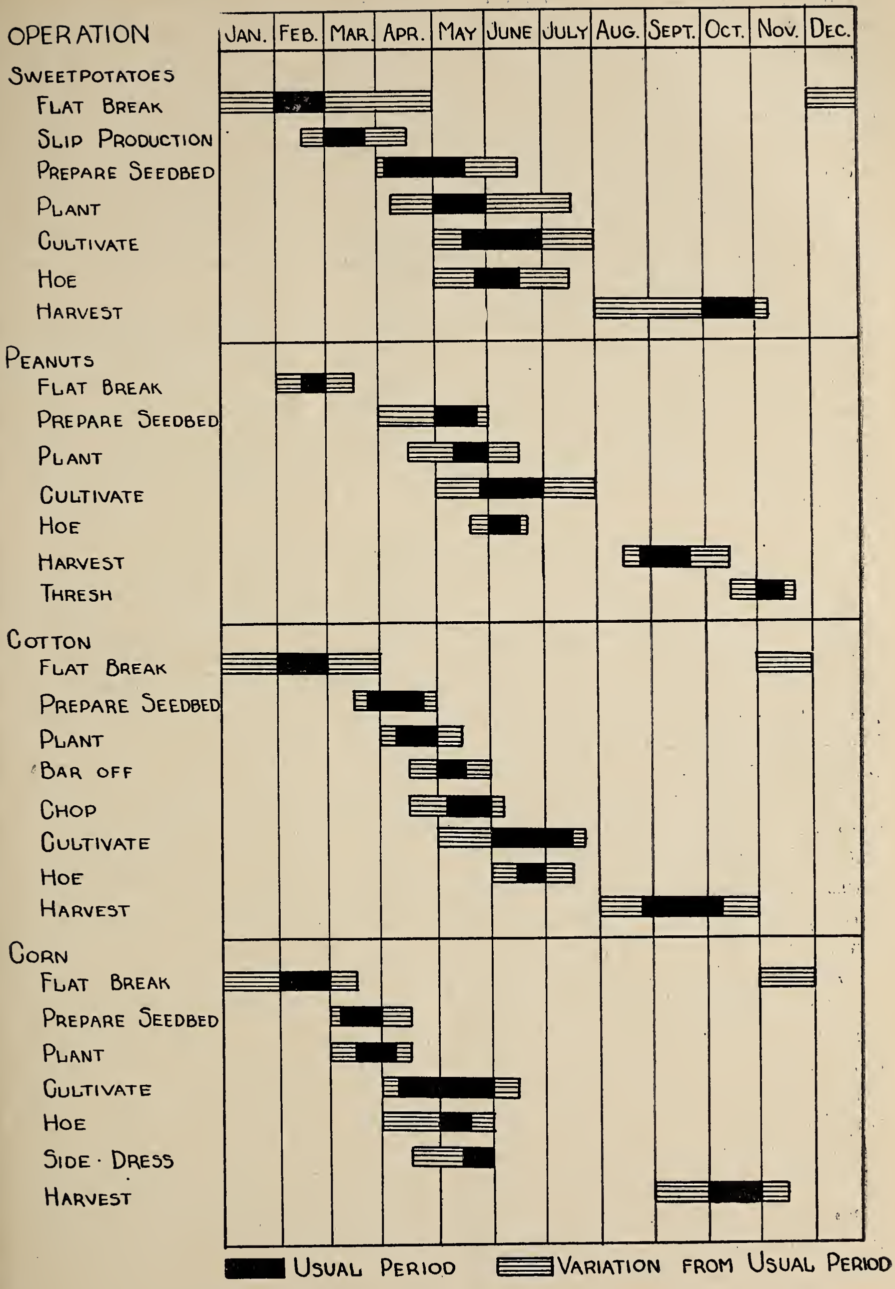

Figure 2.—Comparison of periods when operations are performed on various crops, Bienville and Claiborne Parishes, Louisiana.

grown with the labor required to grow two acres of sweet potatoes. In addition to the total labor requirements, the seasonal distribution of labor is also an important factor in planning the cropping system. Figure 2 indicates when the various operations are usually performed for each of the four crops. All compete more or less directly for labor, especially during the growing season. Corn, however, is planted before the other crops, is laid by earlier, and has a rather flexible harvesting season. As a result, corn has been found to be a good crop to grow along with cotton. During any serious labor peaks, however, the cotton enterprise usually gets first choice of all available labor over corn because of its importance as a cash crop.

Cotton is planted ahead of sweet potatoes. Sweet potato planting extends over a considerable period and conflicts with peanut operations to some extent. During May and June, all of these crops require cultivating and hoeing. Cotton and peanuts are harvested mostly in September, while corn is pulled and sweet potatoes are dug during October. Variations from the usual period for these different labor operations are shown in Figure 2.

RELATIVE RETURNS FROM DIFFERENT CROPS IN 1943

Along with the physical requirements for crop production, the economic aspects must also be considered. Prices, yields, and production costs vary from year to year for each crop and any given crop may not always enjoy the same relative economic advantage. On the basis of the price-cost situation in 1943, however, the sweet potato enterprise in the area studied returned higher net profits to the growers than did cotton, peanuts, or corn.

The average cash costs of production, gross income, and net returns over cash expenses on a per acre basis for each of the four important enterprises are shown in Table 5. Sweet potatoes returned the highest gross cash income, averaging $95.25 per acre. Cotton returned $58.20 per acre; peanuts, $39.83; and the value of corn at going prices was $18.34 per acre.

A comparison of direct cash production expenses shows that sweet potatoes ranked highest with average cash costs of $17.01 per acre. Direct cash expenses for peanuts averaged $12.78 per acre; cotton, $8.21; and corn, $2.70 per acre. Direct cash costs for the production of corn were relatively low compared with the other crops because of the small seed requirements and relatively low fertilizer expenses for this crop.

In returns over cash expenses per acre, or the sum the farmers received to pay for their labor in producing the crop, the costs of workstock, the expenses for use of cropland, and the use of all farm equipment, sweet potatoes averaged $78.24; cotton averaged $49.99; peanuts, $27.05; and corn $15.64 per acre, in 1943.

In any given year, once a farmer has secured his cropland, repaired his equipment, obtained the necessary workstock and secured sufficient feed and housing facilities to maintain them, and organized his farming

TABLE 5. GROSS INCOME, CASH EXPENSES, AND RELATIVE RETURNS PER ACRE FOR SWEET POTATOES, PEANUTS, COTTON, AND CORN, BIENVILLE AND CLAIBORNE PARISHES, 1943

Item	*Sweet Potatoes*	*Peanuts*	*Cotton*	*Corn*
Production per acre	Marketable 70 bu. Other, 33 bu.	Nuts, 475 lbs. Hay, 0.4 ton	Lint, 246 lbs. Seed 384 lbs.	Grain 13.1 bu.
Average price received	Marketable $1.125 bu. Other, 0.50 bu.	Nuts, 6.7¢ lb. Hay, $20 ton	Lint, 19.6¢ lb. Seed, $52 ton	Grain $1.40 bu.
Gross cash value per acre	$95.25	$39.83	$58.20	$18.34
Cash expenses per acre:				
Seed	$9.00	$2.75	$1.18	$0.22
Fertilizer	5.31	3.60	3.69	2.48
Crates	2.50	....	....	....
Threshing and baling	....	4.93	....	....
Ginning, bagging, and ties	....	....	2.84	....
Supplies	.20	1.00	....	....
Hauling to market	....	.50	.50	....
Total	$17.01	$12.78	$ 8.21	$ 2.70
Returns over cash expenses per acre[1]	$78.24	$27.05	$49.99	$15.64

[1] This is the amount available to the operator for paying wages to himself and others, for use of workstock, equipment, land and for overhead expenses.

system so that the other overhead costs must be paid regardless of the combination of enterprises established, his primary interest in the different enterprises maintained is in the return over the direct cash expenses for seed, fertilizer, etc., since all the indirect items of expense listed above must be paid sooner or later regardless of the amounts and kinds of different enterprises established that year. Thus for a short-time comparison for an established farmer, the relative returns over cash expenses is a good indication of the differences in the profitableness of the various enterprises for that specific year, or for the next year if all the various indirect items of expense have already been incurred.

Over a long period of time, however, a farm must not only return sufficient income to pay the direct cash costs for the different enterprises, but also must bring in additional income to cover all of the indirect and overhead costs. Thus, a simple comparison of returns over direct cash expenses for different enterprises is not the best measure of profit to use in planning a long-time farming program or as an indicator of what changes in an established farming program are desirable from one period to another.

In order to establish a basis for making a more accurate comparison of the actual profit or loss for different farm enterprises when both direct cash costs and indirect and overhead costs are considered, it is necessary to make some so-called arbitrary decisions such as the rate of interest to be charged on the investment in cropland and equipment, rates of depreciation, and other similar items. For all of these indirect and overhead cost items, however, a sufficient foundation of research results is available so that charges for each item can be determined with as reasonable a degree of accuracy as that involved in determining the averages for the direct cash cost items. On this basis, the relative returns for sweet potatoes, cotton, peanuts, and corn in 1943, including both the direct cash costs and the indirect and overhead cost items, are shown in Table 6. On the farms studied, most of the man labor involved in the production of the different crops was unpaid labor, since the farm work was done by the farm operator and the members of his immediate family. Thus, the final computation includes no charge for man labor for any enterprise but includes as the measure of profit the average return or profit over all expenses expressed as a return per hour of man labor applied to each enterprise.

The average net return per acre, or the return to the producers for their labor after including both the direct and indirect costs in the production of each enterprise, was $57.82 for sweet potatoes, $35.24 for cotton, $13.29 for peanuts, and $3.22 for corn. The return per hour of labor, however, averaged 47 cents for sweet potatoes, 42 cents for cotton, 24 cents for peanuts, and 10 cents for the corn enterprise. The facts indicate that in 1943 the farmers in this area made relatively good returns from the cotton and sweet potato enterprises, with a slightly higher re-

TABLE 6. RELATIVE RETURNS PER HOUR OF LABOR FOR SWEET POTATOES, PEANUTS, COTTON, AND CORN, BIENVILLE AND CLAIBORNE PARISHES, 1943

Item	*Sweet potatoes*	*Peanuts*	*Cotton*	*Corn*
Hours of man labor per acre	122.4	54.6	82.9	32.7
Cash costs per acre	$17.01	$12.78	$ 8.21	$ 2.70
Indirect costs:				
Horse work[1]	$13.60	$7.83	$8.69	$6.67
Land rent[2]	3.20	3.20	3.20	3.20
Horse equipment use[3]	2.10	1.21	1.34	1.03
Other equipment use[4]	1.52	1.52	1.52	1.52
Total costs excluding man labor	37.43	26.54	22.96	15.12
Gross returns per acre	95.25	39.83	58.20	18.34
Net returns per acre for labor	57.82	13.29	35.24	3.22
Return per hour of labor	.47	.24	.42	.10

[1] Computed by using average horse work requirements of 61.8 hours per acre for sweet potatoes, 35.6 hours for peanuts, 39.5 hours per acre for cotton, and 30.3 hours per acre for corn and multiplying these hour requirements by twenty-two cents per hour, which is the approximate average cost per hour for operating workstock on upland Louisiana farms under 1943 conditions.

[2] Computed by charging an average land cost of eight per cent of the current value of good cropland in the area studied which averaged $40 per acre. This charge includes costs for interest, taxes, drainage, and fencing.

[3] Computed by applying the average cost of horse equipment per hour of horse labor of 3.4 cents as determined from unpublished data by F. D. Barlow and Leo J. Fenske to the actual hours of horse labor required for each crop.

[4] Average cost per acre for hand equipment and proportionate charges for truck and auto costs as determined from Louisiana Bulletin No. 317, by J. Norman Efferson.

turn from sweet potatoes but not sufficiently high to conclude that this enterprise was definitely superior to cotton.

RELATIVE RETURNS FROM DIFFERENT CROPS UNDER AVERAGE CONDITIONS

One year's results cannot be used as a basis for selecting the most profitable crop to grow, hence returns over a longer-run period have been calculated by using average yields, prices, and costs. These data are summarized in Table 7, which indicates the long-time normal cash costs of production, gross income, and returns over cash costs of production for the sweet potato, peanut, cotton, and corn enterprise in the area studied, and Table 8, which indicates the total costs and returns to be expected and the average returns per hour of labor for each of the same enterprises.

Under the long-run price-cost situation, sweet potatoes show up to good advantage, even though a conservative yield of 80 bushels of marketable potatoes was used in the analysis. Returns from sweet potatoes over the direct cash costs of production averaged $53 per acre as compared to $23 for cotton, $14 for peanuts, and $8 per acre for corn. When both the direct and the indirect costs for all enterprises were considered, the sweet potato enterprise returned 31 cents per hour of man labor

TABLE 7. COMPARISON OF NORMAL RETURNS PER ACRE FROM SWEET POTATOES, PEANUTS, COTTON, AND CORN, BIENVILLE AND CLAIBORNE PARISHES.

Item	*Sweet potatoes*	*Peanuts*	*Cotton*	*Corn*
Production per acre[1]	Marketable, 80 bu. Other, 40 bu.	Nuts, 500 lbs. Hay, 0.5 tons	Lint, 233 lbs. Seed, 365 lbs.	Grain, 15.0 bu.
Average price (1935-41)[2]	Marketable, $0.70 bu. Other 0.25 bu.	Nuts, 4¢ lb. Hay, $10 ton	Lint, 10.9¢ lb. Seed, $27 ton	Grain, $0.70 bu.
Gross cash value per acre	$66.00	$25.00	$30.33	$10.50
Cash expenses per acre:[3]				
Seed	$ 6.00	$ 2.25	$ 1.00	$ 0.13
Fertilizer	4.35	3.00	3.08	2.17
Crates	2.00	....	....	....
Threshing and baling	....	4.15	....	....
Ginning, bagging, and ties	....	....	2.45	....
Supplies	.20	1.00	....	....
Hauling to market	....	.50	.45	....
TOTAL	$12.55	$10.90	$6.98	$ 2.30
Returns over cash expenses per acre	$53.45	$14.10	$23.35	$ 8.20

[1] Reported long-run average yields per acre.
[2] From U.S.D.A., Agricultural Statistics, 1936-42.
[3] Costs adjusted to fit the average price period.

as compared with 14 cents per hour for cotton, 6 cents per hour for peanuts, and a loss of 5 cents per hour for corn.

If similar relationships continue, the facts indicate that sweet potatoes can be profitably included in the cropping system in this area, even at the expense of a reduction in cotton or corn acreages. This does not mean, however, that wholesale substitutions of sweet potatoes for other crops now commonly grown in the area is desirable or practical. Producers should obtain growing and marketing experience on small acreages of sweet potatoes before attempting to expand acreages or change the system of farming to include a larger part of the cropland planted to this crop.

OTHER ASPECTS OF THE SITUATION

Sweet potatoes are a source of livestock feed, as cull potatoes can be fed to mules, cattle, and hogs. Recent trials at the North Louisiana Experiment Station show satisfactory and economical gains from hogging off sweet potatoes. If emergency pastures are needed, the vines can be used for pasture, although yields will likely be reduced from 18 to 20 per cent as a result of grazing.[3]

Dehydration facilities have been developed in some parts of the state to meet war needs, and at present, part of Louisiana's sweet potato crop is being dehydrated for human consumption. In the post-war period, sweet potatoes may be dehydrated for feed if the demand for edible use falls off and prices decline low enough. Another development along this line would be the establishment of small dehydrators in local communities to process the culls for feed. The sale of closely graded, high-quality table stock for the fresh market, the sale of off-size but otherwise high-quality potatoes for dehydration for human consumption, and the dehydration of culls for feed should make a desirable combination to result in full utilization of the product. Feeding trials indicate that dehydrated sweet potatoes are nearly equal to corn in feeding value.

Although these factors, in general, show that there may be increased use for sweet potatoes and that the demand for the crop may continue to be just as great after the war as at the present time, these factors were not considered in making the long-time normal estimates as presented in Tables 7 and 8. To do so would have required estimations beyond the scope of established statistical data. Thus, the results under the estimated average conditions are somewhat conservative. In a similar manner, the average yields of the different crops for the most recent 10 year period were used as the basis for establishing production rates, which are somewhat lower than the yields the farmers report as possible in the area and the yields Experiment Station workers report can be obtained under established production practices. Since sweet potatoes are not at present an important crop in the area studied, there is the possibility that farmers, in general, may be able to increase the average yield of this crop relative to the yields of the other important crops and thus still further increase the indicated desirability of the enterprise as a cash crop on many farms in the area.

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[3] 1941-42 Biennial Report of the North Louisiana Experiment Station.

TABLE 8. COMPARISON OF NORMAL RELATIVES RETURNS PER HOUR OF LABOR FOR SWEET POTATOES, PEANUTS, COTTON, AND CORN, BIENVILLE, AND CLAIBORNE PARISHES, LOUISIANA

Item	*Sweet potatoes*	*Peanuts*	*Cotton*	*Corn*
Hours of man labor per acre	122.4	54.6	82.9	32.7
Cash costs per acre	$12.55	$10.90	$6.98	$2.30
Indirect costs:				
Horse work[1]	$9.27	$5.34	$5.92	$4.55
Land rent[2]	2.80	2.80	2.80	2.80
Horse equipment use[3]	2.10	1.21	1.34	1.03
Other equipment use[4]	1.52	1.52	1.52	1.52
Total costs excluding man labor	28.24	21.77	18.56	12.20
Gross returns per acre	66.00	25.00	30.33	10.50
Net returns per acre for labor	37.76	3.23	11.77	—1.70
Return per hour of labor	.31	.06	.14	—.05

[1] Computed by using average horse work requirements for each crop and multiplying these hour requirements by fifteen cents per hour which is the best available estimate, based on several cost studies of the average cost per hour for operating workstock on farms in the upland regions of Louisiana under long-time normal conditions.

[2] Computed by charging an average land cost of eight per cent of the long-time value of good cropland in the area studied, which is estimated to be $35 per acre. This charge includes costs for interest, taxes, drainage, and fencing.

[3] Computed by applying the average cost of horse equipment per hour of horse labor of 3.4 cents (as determined from unpublished data by F. D. Barlow and Leo J. Fenske) to the actual hours of horse labor required for each crop.

[4] Average cost per acre for land equipment and proportionate charges for truck and auto costs as determined from Louisiana Bulletin No. 317, by J. Norman Efferson.

FACTORS AFFECTING SWEET POTATO YIELDS

High yields reduce the per unit cost of production and result in greater net returns than relatively low yields. From year to year, climatic conditions, including rainfall, frost-free season, etc., are most important in determining variations in yields in a general area. In a given year in a specific area, however, variations in yields from farm to farm occur frequently and are due to factors other than climatic conditions.

SOILS AND ROTATIONS

The methods used in this study did not permit any comparison of yields by soil types. The sweet potato fields were mainly located on sandy and sandy loam soils. The fields varied as to natural fertility and suitability for the crop, and yields were undoubtedly influenced by this variation. A well drained sandy loam soil with a clay subsoil is recommended for sweet potatoes in this region.

Sweet potatoes were grown in the rotation with corn and cotton. No definite rotations were followed, but three or four years were usually allowed to lapse before sweet potatoes were put back on the same soil. Although plowing under a green manure crop prior to planting the crop is a recommended practice, very few farmers were following the recommendation. However, winter legumes, oats, soybeans, or some other green crop was frequently turned under at some time in the rotation.

RATE OF FERTILIZING

Sweet potatoes respond readily to proper fertilization. The North Louisiana Experiment Station now recommends 400 pounds per acre of a 4-12-8 or 4-8-8 fertilizer applied when the seedbed is prepared. This recommendation is based on information obtained from experiments being conducted in the various localities of North Louisiana where sweet potatoes are being grown commercially.[4]

The survey data, although not from controlled experiments, show that the heavier fertilized fields produced the highest yields per acre. The relationship of the rate of fertilizing to the yield of sweet potatoes on the farms studied is shown in Table 9.

TABLE 9. RELATION OF THE RATE OF FERTILIZING AND SWEET POTATO YIELDS PER ACRE, BIENVILLE AND CLAIBORNE PARISHES, 1943.

Pounds fertilizer per acre		*Bushels per acre*	
Group	*Average*	*Total*	*Marketable*
Less than 200	108	59.9	42.3
200 - 399	250	96.2	68.6
400 and over	450	121.1	81.4
ALL FARMS	316	101.5	70.2

PLANTS SET PER ACRE

It is generally recommended that sweet potatoes be planted in rows 3½ to 4 feet apart, with the distance between plants in the row depending to some extent on the soil type.[5] Row widths used in North Louisiana conformed closely to those recommended. Table 10 summarizes the data on the rate of planting as related to the yield per acre. The closer spacings produced the highest per acre yields. Since the number of farms studied was too small to cross-tabulate the results, it is impossible to determine whether or not close spacings were associated with heavier applications of fertilizer. It is safe to assume, however, that some of the variations in yield as shown in Table 10 were due not to spacing but to fertilization, soil type, and other factors.

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[4] 1944 Annual report of the Louisiana Agricultural Experiment Station.

[5] Miller, Julian C., and Kimbrough, W. D., *Sweet Potato Production in Louisiana,* Louisiana Agricultural Experiment Station, Bulletin No. 261. December, 1936.

TABLE 10. RELATION OF RATE OF PLANTING SWEET POTATO SLIPS AND YIELDS PER ACRE, BIENVILLE AND CLAIBORNE PARISHES, 1943

Plants per acre *Group*	*Average*	*Bushels per acre* *Total*	*Marketable*
9,000 or less	7,753	79.2	54.7
9,001 - 10,000	9,440	93.6	62.0
10,001 and over	11,362	137.1	97.7
ALL FARMS	9,400	101.5	70.2

DATE OF PLANTING

The yield data could not be refined to the extent that date of planting and yields could be compared. In general, however, most of the farmers reported that their earliest planted slips gave the largest yields. This is in line with experimental data published by different Experiment Stations.

In the North Louisiana Upland Cotton Area, planting cannot take place much before April 15, otherwise danger from late frosts will be encountered. The bulk of the first plantings on the farms studied occurred around May 1. Open beds were used to produce slips on most farms. Slips for early setting can be purchased from commercial plant growers, but usually cost more than home-grown plants.

STORAGE AND MARKETING PRACTICES

If a sweet potato enterprise is to develop successfully in a given area, adequate curing and storing facilities must be available. An estimated storage capacity of 332,000 bushels is available in the North Louisiana Upland Cotton Area.[6] This is made up of four commercial storage houses with a total capacity of 150,000 bushels and approximately 250 farm storage houses with a total capacity of 182,000 bushels. Bienville, Claiborne, and De Soto Parishes have the largest number of farm storage houses.

Commercial production in 1943 for this area was estimated to be 563,000 bushels, thus about 60 per cent of the commercial crop could have been stored if all available space had been used. In 1943, however, about 65 per cent of the commercial crop of this region was sold green, and not all available storage space was needed.

FARM STORAGE HOUSES

In the North Louisiana Upland Cotton parishes, sweet potatoes are frequently stored on the farm in specially constructed storage houses. Of the 43 growers interviewed, 23 producers, or 53 per cent, had farm storage houses. Detailed information was secured on 15 of these farm storage houses. Ten of the houses were constructed of pine logs plastered with mud, while the remaining five were of frame construction. They ranged in capacity from 400 to 1800 bushels, averaging 763 bushels per house. Ventilation was supplied usually by four side openings at the floor level and two ceiling or roof outlets. The houses were heated with wood stoves for the most part, although small kerosene heating stoves were also used in some houses.

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[6] County War Board Estimate.

The bulk of the salable potatoes were stored in crates, but some were stored in relatively shallow bins because of the crate shortage. The culls were usually stored in bins and in some cases were not placed in the storage house. In general, the houses were not used to full capacity in 1943. This does not mean that excess storage capacity exists. Over a long run period, farmers cannot expect to have unlimited demand and ceiling prices for sweet potatoes as soon as they are dug and must plan for an orderly marketing of their product throughout the year if fullest returns are to be obtained. Under normal conditions, the chances are that the area does not now have sufficient storage to market the crop to best advantage.

Table 11 shows the proportion of the crop stored and the extent of the storage capacity used on the 15 farms with storage houses studied in 1943.

TABLE 11. Sweet Potato Production and Storage Capacity on 15 Farms in Bienville Parish, 1943.

Item	*15 farms*	*Average per farm*
Production, bushels	6,933	462
Storage capacity, bushels	11,450	763
Amount stored, bushels	5,631	375
Own crop, bushels	4,291	286
For others, bushels[1]	1,340	89
Per cent of own crop stored	61.9	......
Per cent of storage capacity used	49.2	......

[1] Five stored for others.

About 62 per cent of the sweet potato crop on these farms was put into storage in 1943. In the area as a whole, however, approximately 35 per cent of the crop was stored, the balance being sold green without curing. Roughly one-half of the available storage space on the farms with storage houses was used in 1943, therefore opportunity exists on these farms for expanding the amount of the crop stored if market conditions change from those existing in 1943.

A curing period of 10 to 14 days with temperatures ranging around 85 degrees (F.) is a recommended practice. Nine of the fifteen operators followed this procedure, averaging a 10-day curing period with temperatures from 85 to 90 degrees. The others depended upon the weather being warm enough to cure the potatoes satisfactorily. The houses were heated when necessary during the storage season, so that tempratures remained well above freezing.

Nearly all of the operators reported good success with their storage houses. An average loss of 11.7 per cent from shrinkage was reported, while estimates of usual losses from decay averaged 1.1 per cent during the storage season. Experimental data on storage losses are more reliable than estimates of this kind, but these estimates approach other evidence quite closely. The farmers' estimates on losses from decay, however, are probably low.

FARM STORAGE COSTS

Relatively low cost storage can be secured by the use of farm storage houses. On the group of farms studied, storage costs averaged about eight cents per bushel for the 1942 crop. A summary of the estimated costs is shown in Table 12.

Man labor and depreciation charges were the two largest items of expense, followed by interest charges and fuel costs. The actual cash costs were very low. They included minor repairs and disinfectants.

When suitable logs are available on the farm, the initial cash cost of construction is not very high. Farmers in the Upland Cotton area of North Louisiana should consider the construction of a storage house if storage facilities are not available.

TABLE 12. ESTIMATED COSTS OF STORING SWEET POTATOES IN FARM STORAGE HOUSES, BIENVILLE PARISH, 1942.

Item	*Average annual cost*
	Dollars
Interest on storage house investment[1]	5.60
Depreciation[2]	9.22
Annual repairs	.52
Disinfectants	.21
Fuel	4.78
Man labor (42 hours at 25 cents per hour)[3]	10.50
TOTAL COST[4]	30.83
Average number of bushels stored	375
Cost of storage per bushel	8.2 cents

[1] Charged at 5 per cent of average value.
[2] Calculated by straight line method.
[3] Includes labor for preparing house for storage, and care during storage. Does not include labor for sorting and handling at marketing time.
[4] Excluding losses from shrinkage and decay.

MARKETING PRACTICES

The farmers in the area surveyed marketed their sweet potatoes through several channels. For the most part, local buyers and dealers were the main outlet. These buyers furnished crates and hauled the potatoes from the farm, taking these services into account in the price offered to the farmer. Several farmers sold their product directly to stores and individuals in Shreveport and smaller towns. In 1943, a starch company contracted for sweet potatoes in Claiborne Parish, thus offering a new outlet to producers. One farmer grew potatoes for seed sales and for commercial plant production. A summary of the methods of disposal is given in Table 13.

TABLE 13. MARKET OUTLETS OF SWEET POTATO PRODUCERS IN BIENVILLE AND CLAIBORNE PARISHES, 1943.

Market outlet	*Number of cases*	*Per cent of total*
Sold to local buyers[1]	26	60.5
Sold directly to stores and individuals	10	23.2
Sold to starch company	6	14.0
Sold for seed purposes	1	2.3
TOTAL	43	100.0

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[1] A small proportion of the early crop was sold to stores and individual consumers, but the main crop was sold to local buyers.

Some differences were noted in marketing practices between the group with storage houses and those without farm storage facilities. A larger percentage of the crop was stored and sold later in the season by the former group than the latter. This difference will probably be much greater during long-time normal demand and price relationships. Table 14 summarizes with the extent of storage on these two groups of farms.

TABLE 14. METHOD OF HANDLING SWEET POTATO CROP IN BIENVILLE AND CLAIBORNE PARISHES, 1943.

Method of Handling	*Per cent of marketable crop*		
	All farms	*Farm storage*	*No farm storage*
Stored for later sales	37.4	57.2[1]	9.0[2]
Sold green	62.6	42.8	91.0
Early market	8.9	10.0	7.0
Main crop	53.7	32.8	84.0

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[1] Farm storage houses.
[2] Commercial storage.

On farms with storage houses, more than half of the marketable crop was placed in storage at digging time for later sales. Ten per cent of the crop was sold in the early market and the remaining one-third sold green at digging time. The need for cash and the relatively favorable prices prevailing at harvest time encouraged selling instead of storing in 1943.

The group without storage facilities sold 91 per cent of their marketable potatoes at harvest time, and stored only 9 per cent. The proportion of the crop sold early was smaller on these farms than on the others. Those without adequate storage facilities usually sold to buyers at the field.

For all farms in the sample, slightly more than one-third of the 1943 crop was stored, the balance being sold green.

PROBLEMS IN EXPANDING PRODUCTION

Farmers in the North Louisiana Upland Cotton Area have long depended upon cotton as their cash crop, thus cotton culture is firmly entrenched in the economy of the area. Hence, several important problems must be faced if the sweet potato enterprise is to be expanded in the area.

A lack of suitable cropland is not a limiting factor in this region. In 1943 only 12 per cent of the land classified by the farmers as being suitable for sweet potato production was devoted to the crop on the farms studied.

The labor situation presents some difficulties in increasing sweet potato acreages from two standpoints. With a war-created labor shortage in existence, farmers are reluctant to expand a high-labor requirement crop like sweet potatoes even with the prospect of increased returns because of the difficulty of obtaining sufficient labor during peak periods. In addition, the farm labor in this area, as elsewhere in the South, is largely experienced in cotton production. Farm operators may experience difficulty in getting their tenants, croppers, and hired laborers to handle a crop with which they are more or less unfamiliar.

Another factor retarding the expansion of sweet potatoes (and other new crops) is the unorganized marketing system. This has proved to be the case with peanuts in this same region. Cotton, on the other hand, has a ready market if farmers are willing to sell at prevailing prices. Sweet potato producers in the North Louisiana Upland Cotton Area have somewhat poorer market channels than those found in the old commercial areas of the state. In the Gibsland area, however, three buyers were operating storage houses having a combined capacity of 70,000 bushels. Shreveport also provides a fairly large local market for farmers in this area.

Several farmers in Claiborne Parish produced sweet potatoes under contract for dehydrating purposes in 1943. Many of them were first-year growers. Yields were low because of the drought and returns were unsatisfactory. This experience does not necessarily mean that this type of production has no place in the area. It should be recognized, however, that this region has less fertile soil, in general than some of the other sweet potato areas in the state, and average yields cannot be expected to be as high as those obtained in some of the regions producing sweet potatoes primarily for dehydration purposes.

Another problem to overcome is to eliminate all rough handling of the product during harvesting and the subsequent storing and marketing periods. Sweet potatoes cannot be bruised or roughly handled if keeping qualities are to be retained. New growers can profit by observing the practices followed by experienced men, both in producing and in harvesting sweet potatoes.

SUMMARY

1. Sweet potatoes are quite generally grown in the North Louisiana Upland Cotton Area but are produced mainly for home use. The area has potentialities for commercial production since both soil and climatic conditions are favorable for sweet potato growing and

some growers in the region have developed the crop into a profitable cash crop in recent years.

2. Production on the farms studied is characterized by hand planting and half-row cultivating operations. The fields were relatively small, averaging about 4 acres per farm.
3. Man labor requirements for sweet potatoes are relatively high. Sweet potatoes produced with horse power required 122 man hours and 62 horse hours per acre, as compared with 106 man hours per acre where a tractor was used for part of the operations. Power requirements for this group of farms averaged 25 horse hours, 7 tractor hours, and 5 truck hours per acre.
4. The use of transplanting machines reduced man labor requirements from 25 man hours to 15 man hours per acre. In addition, the planting could be done without waiting for favorable weather.
5. Sweet potatoes were a relatively profitable crop in the North Louisiana Upland Cotton Area in 1943, returning about 47 cents per hour of man labor and bringing higher returns over all expenses per acre and per hour of man labor than cotton, peanuts, or corn. Also, under long-time average cost-price relationships, sweet potatoes are in a strong competitive position when compared with cotton, peanuts, and corn.
6. Sweet potatoes are a source of livestock feed, and as dehydration facilities develop, the culls can be processed as a more valuable feed. Dehydrated sweet potatoes compare favorably with corn in feeding value and can be stored as any other concentrate.
7. High yields are desirable because per unit cost of production is reduced. Several factors under the control of the farmer affect yields. The survey data show that the best yields were obtained on fields that received 400 pounds of fertilizer per acre. The closer spacing also gave higher yields.
8. Sweet potatoes were economically and successfully stored in small farm storage houses. The farmers with storage houses were generally following recommended practices as to handling and curing the product. Storage costs in 1942 averaged 8 cents per crate in farm storage houses.
9. Several problems must be overcome before sweet potato acreage will expand greatly in the North Louisiana Upland Cotton Area. A labor shortage acted as a deterrent during the war. Also, farmers must become more experienced in the various tasks connected with the growing and handling of sweet potatoes, such as proper seed selection, growing of better and earlier plants, and improved cultural and fertilizer practices. Markets are not highly developed except in certain localities. Land is apparently not a limiting factor.
10. As farmers gain in experience with the crop and as market outlets become better developed, sweet potatoes can be grown to a larger extent in this area. Farmers in this region should investigate fully the possibility of producing the crop as a commercial cash enterprise.

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EFFECT OF CERTAIN SUMMER AND WINTER LEGUME CROPS IN IMPROVING CORN YIELDS IN SOUTH LOUISIANA

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EFFECT OF CERTAIN SUMMER AND WINTER LEGUME CROPS IN IMPROVING CORN YIELDS IN SOUTH LOUISIANA

H. B. BROWN[1]

INTRODUCTION

All farmers know that land which contains considerable humus or organic matter works well, does not dry out or "bake" as quickly as land low in organic matter and that it produces better crops. Some authorities (13)[2] are of the opinion that now our uncropped virgin soils do not contain as much organic matter as they once did due to the frequent practice of burning annually the leaf litter in forests and the dead grass on prairies and open fields. This practice probably does have considerable effect in some areas where it is followed rather generally.

Over much of Louisiana, and especially in the southern part of the State, where the rainfall is fairly heavy and the weather moderately warm during most of the year, it is a rather difficult task to maintain the supply of organic matter in the soil. These weather conditions so favor bacterial action that the decomposition of organic matter is active most of the year. Then, too, where the rainfall is heavy and the land does not have a good cover of vegetation, the soil tends to erode rapidly and lose valuable plant nutrients by leaching. This is especially true on rolling lands not protected by a plant cover.

As pointed out by Kell and McKee (14) soil loss due to erosion is almost entirely responsible for the nearly complete destruction of about 50 million acres of once fertile land in the United States and another area of almost equal extent is in almost as bad condition. Erosion has removed the greater part of the top soil from approximately 100 million acres more; unless checked promptly, erosion will, to a large extent, destroy the productivity of this area. And the end is not here—erosion is getting underway in many other areas.

The work of the Soil Conservation Service in building terraces and encouraging the growing of summer or winter cover crops is helping to lessen this soil destruction in limited areas. Its work must depend on educational effects for extended results. Extensive practice by farmers of growing summer or winter cover crops, and sod crops in rotation will do much toward protection against soil losses. Any plant that affords a good ground cover may be termed a cover crop and it of course may have beneficial effect in adding organic matter to the soil and preventing the soil from washing away. However, the term "cover crop" is applied more specifically to crops such as rye, oats, vetch, soybeans, cowpeas, Crotalaria, etc., that are planted especially to protect the soil from erosion and to add organic matter to it.

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[1] Credit is due John R. Cotton for making the statistical computations used in this bulletin.

[2] The numbers refer to references given at the end of the bulletin.

Kell and McKee (14) in their valuable bulletin mentioned advantages from the use of a cover crop as follows:

> "1. Reduces runoff of rain and thus conserves moisture (a rug for rain-worn soils).
>
> "2. Prevents excessive erosion of soil.
>
> "3. Improves the soil tilth by the addition of organic matter to the soil.
>
> "4. Prevents the leaching of available plant food, especially nitrate nitrogen.
>
> "5. When turned under, forms organic acids or other compounds, which aid in the liberation of mineral plant food.
>
> "6. May provide late fall, winter and early spring pasture.
>
> "7. Protects newly constructed terraces and other mechanical soil-erosion devices.
>
> "8. Increases yield of corn, cotton, and other regular farm crops.
>
> "9. Increases the water-absorbing capacity and the infiltration of water into the soil."

Although as pointed out above, there seem to be numerous and important advantages to be gained from planting cover crops, their use has not become as widespread as might seem desirable. There are several reasons for this. In north Louisiana it is often hard to get a stand with fall-sown crops. This is especially true during dry seasons. On many fields the cover crop will not make much growth unless the land is fertilized—given an application of superphosphate. If money is scarce, the farmer may hesitate at buying fertilizer and paying 6 or 8 cents a pound for seed to plant a crop that is not always certain. If the soybean or some other legume is planted in the corn when the corn is planted, it may affect the corn adversely by using moisture and nutrients needed by the current crop of corn. It sometimes happens, too, that a winter cover crop affords a harboring and breeding place for certain harmful insects that attack the plants in the regular crop that follows. This happens most frequently in south Louisiana.

This bulletin contains a revision of Louisiana Experiment Station Bulletin No. 265, entitled "Effect of Soybeans on Corn Yields," which was published comparatively recently but is now out of print and a discussion of the results from two projects recently completed. One was on the effect of various summer legumes on corn production and the other on the effect of different winter growing legumes when used as a volunteer winter cover crop.

EFFECT OF SOYBEANS ON CORN YIELDS WHEN PLANTED AND HANDLED IN VARIOUS WAYS

During recent years there has been a decided increase in the number of acres of soybeans grown in the United States. In the Northern States, the plant is grown for hay, soil improvement, and for the grain or seed from which oil is extracted and food made. In the Southern States the plant is used principally for hay and for improving the soil.

With the increase in the use of the soybean have arisen many questions in regard to its use in cropping systems and in corn culture. A number of experiment stations have carried on cultural experiments, but results have differed considerably, due, no doubt, to the different soil and environmental conditions prevailing at various places. The kinds of soybeans grown and conditions vary so much that it is necessary to conduct many experiments.

Material and Methods

The soil in southern Louisiana is generally fertile and there is usually abundant rainfall. Plants tend to make luxuriant vegetative growth. The particular land used in the experiments mentioned below was land that had been farmed for many years but was in fair condition in respect to fertility. Experiments 1, 2 and 4 were conducted on Lintonia silt loam, 5 and 6 on mixed Olivier and Calhoun soils in a small branch bottom, while experiment 3 was run on Mississippi River alluvial land. All the plots were fertilized each year before planting with 300 pounds of 16 per cent superphosphate, 50 pounds of nitrate of soda and 50 pounds of muriate of potash per acre.

Cocke Prolific, a vigorous-growing, medium-late, prolific variety of corn, was used in experiments 1, 2, 4, 5 and 6, while Yellow Creole, a variety similar in period of maturity and vegetative growth, was used in the third. Otootan soybeans, or another variety of the same spreading and viney type, was used.

Except in the rate of seeding test, the planting was done with a one-horse planter on which there was a duplex hopper with six cups on a side. This planted hills of corn and beans in alternation, the hills being 27 inches apart. The rows were four feet apart. There were from three to five kernels of corn and six or eight beans dropped in a hill. The seeds of both were scattered somewhat as they fell. In 1933 the corn plants were thinned to two in a hill. Other years they were thinned to one stalk. The beans were not thinned. Good stands were secured as a rule, but they were damaged somewhat by birds and insects. Some replanting was done nearly every year.

Four- or five-row plots containing approximately one-twentieth acre each were used with three to five replications. Only the two or three middle rows of the plots were harvested for experimental weights. The corn was planted about March 20 each year. This is considered a good date for planting corn in the locality.

EFFECT OF SOYBEANS ON CORN YIELDS WHEN PLANTED IN THE CORN ROW AT THE TIME THE CORN IS PLANTED

As a rule soybeans growing in a row of corn tend to interfere with the growth of the corn somewhat as weeds do when growing in the row. The heavier the growth of the bean vines, the poorer the soil, and the scarcer the supply of moisture in the soil, the more harm the beans do. In general it appears that they do more harm to the corn in the Northern States than in the South.

Hackleman (1) and others at the Illinois Experiment Station in a four-year test found that in checked corn, soybeans planted in the hills of corn reduced yields of corn 10.17 per cent, but that the combined feeding value of the corn and soybeans was considerably more than that of the corn alone. The digestible protein per acre on the "corn alone" plots was 136.3 pounds, while the protein from corn and Ebony soybeans was 212.5 pounds; corn and Hong Kong soybeans, 204.6 pounds; and corn and Ito San soybeans, 165.2 pounds. The Ito San soybeans, an early dwarf type, damaged the corn less than the others, but made the least protein.

Thatcher (2) of the Ohio Experiment Station reports that, in a five-year test of corn and soybeans, at a medium rate of planting (corn plants 12-14 inches apart and soybeans 4-5 inches) the corn and soybeans together yielded 34.9 pounds more grain per acre than the corn alone. Sixteen and four-tenths (16.4) per cent of the grain mixture was soybeans.

At the Kentucky Station (3) in a six-year test there was an average loss of 5.7 bushels of shelled corn per acre when soybeans were planted in the corn, while the beans yielded 3.5 bushels of grain per acre.

The Missouri Experiment Station (4) reports that a five-year average yield of corn on average upland soil was 42 bushels per acre. In a corn and soybean combination on the same land during the same period the yield of corn was 35 bushels per acre and the soybeans 3.5 bushels.

Mooers (5) of the Tennessee Experiment Station reports that the average yield of six crops of corn grown with soybeans on land of good productivity was 32.3 bushels per acre; whereas, under otherwise like conditions, corn alone produced 49.9 bushels, or 17.6 bushels more per acre. The grain yields of the beans in the corn were 17.1 bushels per acre. This just about balanced the corn loss. If the feeding value of the combination crop or its effect on the soil is considered, it is evidently the more desirable crop of the two.

Ayres (6) of the Mississippi Delta Experiment Station at Stoneville, Mississippi, reports averages of a four-year test of corn and soybeans on alluvial land as follows: corn alone, 24.2 bushels per acre; corn and beans in same row and planted at the same time, 17.7 bushels of corn and 7.1 bushels of beans. The grain total of the combination crop was 24.8

bushels, which was slightly more than the corn alone. When the beans were planted in the row of corn three weeks after the corn was planted, the corn produced a yield of 22.5 bushels of grain.

Kuykendall (15) in other corn-legume experiments conducted on the same Delta Experiment Station farm some years later, obtained no reduction in corn yield the first year when soybeans were planted in the corn at corn planting time, and a gain of 15 bushels per acre the second year when so planted. Weather or soil conditions must have been different from the ones under which Ayres' experiments were conducted.

Haddon (22) of the Northeast Louisiana Experiment Station reports, on basis of a four-year average, that corn alone produced 33.2 bushels per acre; corn and beans cut for hay and stubble turned under in the fall, 33.1 bushels of corn grain per acre; and corn and beans with whole plants turned under in the fall, 41.5 bushels corn per acre.

Some carefully conducted experiments have given evidence to the effect that certain legumes grown in association with non-legume crops may add nitrogen to the currently associated non-legume. Lyon and Bizzell (16) found that timothy plants growing with alfalfa or red clover contained more protein than timothy growing alone. Oats growing with Canada field peas also contained more nitrogen than oats growing alone. Like results have been obtained by Lipman (17) and by Evans (18). While this transferal is probably possible, it is doubtful if it is of great practical value.

Experiments similar to the ones mentioned above have been carried on by other experiment stations. Results have been similar. In practically every case there was considerable decrease in the grain yield of corn when soybeans were planted with the corn, but this loss was about balanced by the weight of the bean grain. Very few of the experimenters state whether or not the corn and beans were grown on the same land successive years. Since they do not mention any improvement of the soil due to the continued use of the beans, it may be assumed that the corn and bean plots were moved from year to year.

LOUISIANA EXPERIMENTS

In 1929 experimental work was started by the Louisiana Experiment Station to obtain some information on the questions mentioned on the first page of this bulletin.

1929 EXPERIMENTS

Corn yields depend to a considerable extent on the amount of rainfall and on its distribution throughout the corn growing season. The dependence is even greater when soybeans are planted in the corn. The following weather tables show the Baton Rouge rainfall from March to August for the years that the experiments were run and may be of some aid in interpreting results.

RAINFALL AT BATON ROUGE, LOUISIANA—1929

Month	*Total for month*	*Departure from normal*	*Number of days with .01 or more inches of rain*
March	5.40	+0.55	8
April	1.76	−2.93	6
May	9.30	+4.50	12
June	5.90	+1.11	13
July	3.75	−3.02	13
August	6.21	−0.45	12

PLOT WEIGHTS OF EAR CORN—1929

Series	*Plots with corn and beans*			*Plots with corn alone*		
I	22.6	18.5	16.4	29.1	23.8	26.1
II	16.5	14.4	13.1	23.4	24.9	21.5
III	24.7	20.7	19.2	24.9	28.8	35.6
IV	22.4	22.1	24.7	33.7	34.1	30.4
V	17.9	20.2	21.0	29.0	36.8	38.8
Total weight	294.4			440.7 pounds		
Bushels per acre	28.0 ± .87			41.9 ± 1.34		

The plots with soybeans had an average of 31 stalks per row, while the ones without beans had 37.6 stalks. Figuring the yields on the basis of equivalent stands, the yields are 33.9 and 41.9 bushels per acre. This makes a difference of eight bushels per acre. Basing yields on stalk numbers in this way probably gives the plots with the lower number of stalks some advantage. However, the plots without beans had more stalks blown down or lying on the ground, and the ears were heavier because they contained more moisture. These two factors practically balance each other. Using the figures for equivalent stands, the plots with beans yielded 19.1 per cent less corn than the ones without beans.

The beans in the plots made vigorous growth and covered all the space between the rows. A yield of 4020 pounds of dry soybean hay was made. There was a fair crop of bean seed, but these were not harvested. All of the bean residue was left on the land each year.

RAINFALL AT BATON ROUGE, LOUISIANA—1930

Month	*Total for month*	*Departure from normal*	*Number of days with .01 or more inches of rain*
March	4.91	+0.06	14
April	2.01	−2.68	3
May	6.23	+1.43	7
June	T.	−4.79	0
July	4.92	−1.85	10
August	4.85	−0.91	9

The "corn alone" plots yielded several more bushels of grain than the plots with beans, but, if we consider the value of the soybean hay produced and in addition the soil improvement from the use of the beans, it was evidently more profitable to have them.

The corn-growing period of 1930 was considerably below the normal in amount of rainfall.

PLOT WEIGHTS OF EAR CORN—1930

Series	Plots with corn and beans			Plots with corn alone		
I	13.2*	13.2*	13.3	22.2	20.4	19.7
II	8.2	9.1	10.5	15.3	16.3	14.4
III	12.0	11.6	11.7	18.0	18.8	18.3
IV	10.7	10.4	8.4	18.2	15.1	14.2
V	10.6	12.5	12.5	12.7	15.0	23.4
Total plot weight	167.9			262.0 pounds		
Bushels per acre	25.9 ± .67			40.7 ± 1.87		

* A part of each plot was blocked off and not harvested for yield.

The season of 1930 was drier than a normal season and the soybeans in the corn reduced yields more than usual. There was a loss of 33.6 per cent due to the effect of the beans. A yield of 2736 pounds of soybean hay was produced.

RAINFALL AT BATON ROUGE, LOUISIANA—1931

Month	Total for month	Departure from normal	Number of days with .01 or more inches of rain
March	4.32	−0.53	9
April	2.27	−2.42	8
May	5.31	+0.61	9
June	1.84	−2.95	6
July	6.42	−0.35	14
August	8.23	+2.47	16

The crop season of 1931 had less rainfall than a normal season.

PLOT WEIGHTS OF EAR CORN—1931

Series	Plots with corn and beans			Plots with corn alone		
I	20.8	19.9	18.8	13.0	11.0	12.8
II	15.4	15.5	14.3	12.8	12.4	16.7
III	15.3	17.3	13.6	13.5	17.5	14.6
IV	12.0	11.1	15.3	11.2	17.8	13.1
V	13.8	15.4	13.7	13.5	9.3	16.3
Total plot weight	232.2			205.5 pounds		
Bushels per acre	22.1 ± .68			19.6 ± .68		

The season of 1931 was too dry for good corn yields. The soybean plots that year made slightly higher yields than the "corn alone" plots. The beans had some beneficial effect on the soil, probably because the plots that had grown beans made 12.7 per cent more corn than did the plots which had not had beans. The soybeans made good growth, but no hay weights were taken.

RAINFALL AT BATON ROUGE, LOUISIANA—1932

Month	*Total for month*	*Departure from normal*	*Number of days with .01 or more inches of rain*
March	3.21	−1.68	7
April	5.49	+1.11	7
May	8.39	+3.66	11
June	2.80	−1.97	7
July	7.53	+1.15	15
August	5.52	−0.12	15

The rainfall during the growing season of 1932, with the exception of May which was rather wet, was nearly normal.

PLOT WEIGHTS OF EAR CORN—1932

Series	*Plots with corn and beans*			*Plots with corn alone*		
I	23.0	24.5	23.5	21.0	18.5	17.0
II	21.5	27.0	26.5	21.0	19.0	18.0
III	24.0	24.5	25.5	16.0	18.0	15.5
IV	22.5	26.0	23.5	13.5	13.5	17.0
V	34.0	36.5	31.0	18.0	16.0	18.5
Total plot weight	393.5			260.5 pounds		
Bushels per acre	40.5 ± 1.21			26.7 ± 60.		

Yields were fairly good in 1932. The bean plots outyielded the others by 51.7 per cent. The growth of the bean vines was good, 3478 pounds per acre of dry hay being produced.

RAINFALL AT BATON ROUGE, LOUISIANA—1933

Month	*Total for month*	*Departure from normal*	*Number of days with .01 or more inches of rain*
March	5.06	+0.17	9
April	7.92	+3.54	10
May	4.41	−0.32	5
June	3.83	−0.94	6
July	6.39	+0.01	20
August	5.72	+0.08	15

Except for April the rainfall during the 1933 corn-growing period was about normal.

Plot Weights of Ear Corn—1933

Series	*Plots with corn and beans*			*Plots with corn alone*		
I	26.0	22.6	25.8	16.0	13.1	11.7
II	18.5	12.0	15.3	13.0	11.7	9.0
III	17.1	17.1	18.5	12.7	14.6	15.9
IV	15.3	16.6	14.3	10.6	13.9	15.8
V	17.5	16.6	15.7	13.0	14.1	13.4
Total plot weight	268.9			198.5 pounds		
Bushels per acre	33.0±1.27			24.5 ± .63		

During the fore part of the growing season of 1933 the corn in the corn and bean plots made splendid growth and gave promise of making much better yields than the corn in the "corn alone" plots. However, during June the weather became rather dry for corn. The corn in the corn and bean plots was affected worse than in the other plots (see figure 1) and lost some of its margin, but it yielded more than the corn in the other plots by 35.2 per cent. As may be seen in figure 1 the beans in the corn and bean plots made good growth. Though the hay samples were taken before the beans had reached full growth, the hay yield was 2200 pounds per acre. The corn stover in the corn and bean plots weighed 5.8 tons per acre, while the stover from the "corn alone" plots weighed 4.4 tons. It was observed that the corn plants fired worse in the "corn alone" plots than in the other set and that the soil renovating effect of the soybeans affected the two outer rows of the adjacent plots which had no beans. The effect was confined principally, though, to the outside row.

Fig. 1. Corn plots with and without soybeans
a. Corn and soybeans
b. Corn alone

Figure 2 shows graphically the grain yields of both sets of plots for the entire period. There are some irregularities in the curves due to weather conditions of different years. However, it will be observed that the general trend of the curve for "corn alone" plots is downward, while that for the other plots is upward. The land at the beginning of the experiment was in fairly good condition and gave good yields on the "corn alone" plots. After the first two years there was a decided fall off in production in the "corn alone" plots. The soybeans in the other series of plots lowered yields decidedly the first two years compared with the "corn alone" plots, but after that their beneficial effect on the soil began to show and yields were increased.

Table 1 brings together averages of data collected the different years the experiment was run. Most of this was mentioned in previous discussions. The yields of soybean hay shown in column 3 show considerable variation, although there was a good crop grown every year. The difference in weights is due largely to the time of cutting.

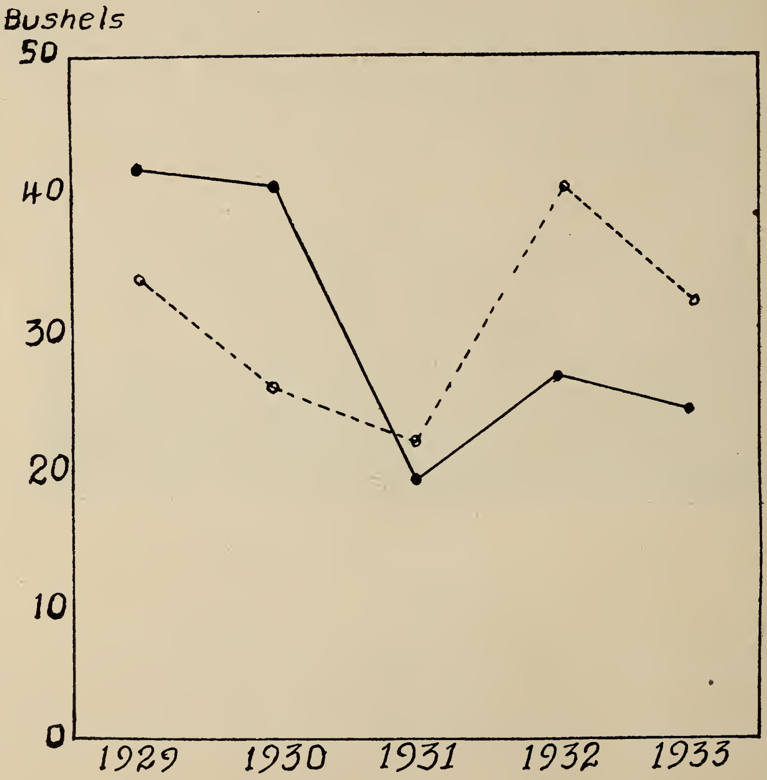

Fig. 2. Bushels of corn per acre with and without soybeans planted in the row of corn when the corn was planted.

Without Soybeans ——————— With Soybeans - - - - - - - -

TABLE 1. Summary of Data on the Effect of Soybeans on Corn Production When the Beans Were Planted in the Corn Row When the Corn Was Planted

Year	*Bushels corn in "corn alone" plots*	*Bushels corn in corn and bean plots*	*Bean hay per acre on corn and bean plots*	*Av. No. stalks per row*		*Corn stover on "corn alone" plots*	*Corn stover on corn and bean plots*	*% gain or loss from use of beans*
				"Corn alone"	*Corn and beans*			
1929........	41.9±1.34	28.0± .87	4020 lbs.	37.6	31.0	....	....	−19.1
1930........	40.7±1.87	25.9± .67	2736	38.0	36.3	....	....	−33.6
1931........	19.6± .61	22.1± .68	....	47.0	45.0	....	....	+12.7
1932........	26.7± .60	40.5±1.21	3478	48.0	44.0	....	....	+51.7
1933........	24.4± .63	33.0±1.27	2200	59.7	67.8	8800 lbs.	11,600 lbs.	+35.2

The number of stalks per row, shown in columns 4 and 5 of table 1, varied some, although the same amount of seed was planted in each row each year. Four years out of the five the "corn alone" rows had the larger number. This probably gave the "corn alone" plots a slight advantage although the advantage was somewhat less than the difference in the number of stalks would indicate. If the number of stalks is increased, the yield of each stalk is somewhat less.

Columns 6 and 7 show that considerably more corn stover was produced by the corn and bean plots in 1933 than was produced on the "corn alone" plots. Unfortunately corn stover yields were not taken other years. It was very evident though, judging from the looks of the corn, that there was more corn stover on the corn and bean plots during the later years of the experiment. During the first two years the "corn alone" plots probably made more.

Every year the soybeans made good growth and covered practically all of the ground both in the rows and between. This served to prevent the growth of grass and weeds on the bean plots. There was considerable growth of grass and weeds on the other plots after the corn was laid by. All of the plots were plowed during the fall each year and summer growth turned under. During the winter there was a prolific growth of chickweed and other winter annuals on the plots that had grown beans, but slight growth on the others. A large number of Diabrotica beetles was observed to be wintering on this growth, during the winter of 1932-33. It was feared that these beetles would cause much budworm trouble in the corn on the bean plots the following spring, but a count of infested plants in the plots showed worse infestation in the corn where there had been no beans. We cannot give the reason for that. The covering of winter weeds probably lessened erosion to some extent. The corn

TABLE 2. Analysis of Soil in Corn and Soybean Test*

Plots	*Total organic matter* %	*Total phosphoric acid* %	*Total nitrogen* %	*Potash (acid soluble)* %	pH
1. Corn and beans	2.060	.120	.103	.170	6.1
2. Corn alone	1.620	.105	.081	.150	6.1
3. Corn and beans	1.560	.0975	.078	.240	5.9
4. Corn alone	1.440	.090	.072	.250	5.8
5. Corn and beans	1.620	.0875	.081	.150	5.9
6. Corn alone	1.580	1.000	.079	.130	5.7
7. Corn and beans	1.680	.095	.084	.240	5.7
8. Corn alone	1.440	.080	.072	.180	5.7
9. Corn and beans	1.660	.080	.083	.210	5.8
10. Corn alone	1.620	.095	.081	.180	5.7
Averages					
Corn and beans	1.716	.096	.085	.202	
Corn alone	1.540	.094	.077	.178	

* The soil analysis was made by A. P. Kerr and his associates.

stalks on the corn alone plots lodged or blew down worse than on the other plots.

During the winter of 1932-33 ten samples were taken from the topsoil of each plot in the corn and soybean experiment and an analysis made. The results are shown in table 2. When the samples were taken, the experiment had run four years on the same plots. The effect of the soybeans seems to be reflected rather clearly in the soil analysis. There is a considerable increase in organic matter in the soil, as was to be expected, and a good increase in total nitrogen. There also appears to be a decided increase in the amount of potash. This, however, may be more apparent than real.

RESIDUAL EFFECT OF SOYBEANS IN CORN ON THE FOLLOWING COTTON CROP

It has been seen that growing soybeans in corn increased the yield of corn on the plots in subsequent years and also improved the chemical composition of the soil. It has been observed by many cotton planters that the growing of a crop of corn and soybeans one year has a decidedly beneficial effect on the cotton crop that follows the next year. Ayres (6) of the Mississippi Delta Station secured an increase of 657 pounds of seed cotton per acre from soybeans planted in the corn row at the time the corn was planted, 717 pounds increase when planted in the row three weeks after the corn was planted, and 836 pounds increase when planted in rows alternating with the corn rows.

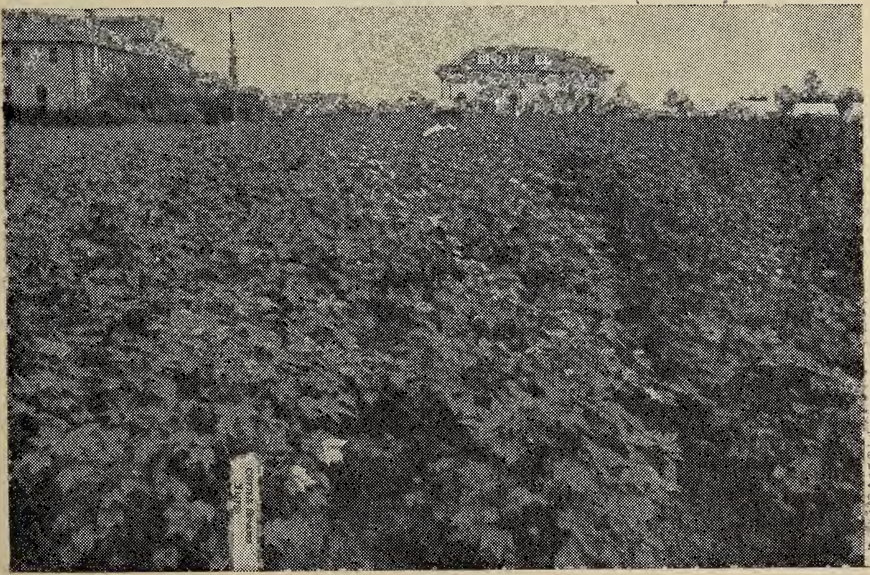

Fig. 3. Cotton on land that had grown corn and soybeans for five years.

In the Louisiana experiments, cotton on the land that had been in corn and soybeans for five years made a much more vigorous growth than cotton that followed corn alone. Compare figures 3 and 4. The average height of the cotton plants on the bean plots was 39.9 inches, while the average height of the cotton plants on the other plots was 27.5 inches. The cotton on the plots that had grown beans made approximately 100 per cent more cotton than the cotton on the other plots. The yield was reduced by boll weevils and in neither case was great, being 937 pounds seed cotton per acre on the higher yielding plots.

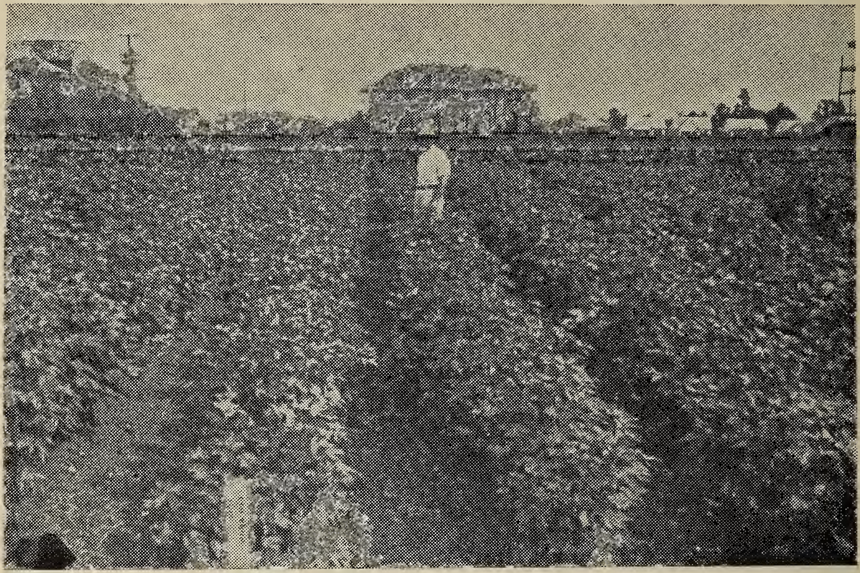

Fig. 4. Cotton on land that had grown corn alone for five years.

Haddon (22) of the Northeast Louisiana Experiment Station reports, on basis of a six-year average, an increase of 937 pounds of seed cotton per acre on land on which soybeans and corn stalks had been turned under the previous fall and an increase of 561 pounds where the corn stalks and soybeans were cut for hay and only the stubble turned under.

CORN AND SOYBEANS FOR SILAGE

Several experiment stations have carried on experiments to determine the value of planting soybeans in corn for silage. Results have varied some. The Ohio Station (2) compared Clarage corn, a variety maturing a grain crop in a normal season, and Blue Ridge corn, a late silage variety, with and without soybeans, for silage during a seven-year period. Clarage corn alone averaged 8.28 tons of silage per acre and Clarage corn and soybeans, 7.96 tons; Blue Ridge corn alone, 12.57 tons and Blue Ridge and soybeans, 12.23 tons. The combination crop was slightly lower in yields but probably of a higher feeding value, due to the higher protein content of the soybeans.

Odland (7) of the West Virginia Station, as a result of experiments carried on for five years, found that there was neither a significant increase or decrease in total yield of the combination crop as compared with corn alone if the corn was planted at the same rate as in the combination. He concluded that the advantage of the combination must come from its higher feeding value.

The Connecticut Experiment Station got an increased yield of about a ton of green matter from the combination crop. The Iowa Station also secured increased yields. Others have obtained similar results.

Unfortunately, in our experiments the corn stover weights were taken only one year. This year, which was the last year the experiment was run, showed an increase of 4.7 tons of green matter per acre for the combination crop. If weights had been taken the first two years of the experiment, the gains would have been much less.

In none of the experiments from which we have seen data has the total value of the silage been reduced by growing beans in the corn. Other experiments have shown a decided increase. Since the use of the beans makes the silage considerably richer in protein, it seems that there is no question but that it is advisable to use them.

ECONOMY OF GROWING CORN AND SOYBEANS TOGETHER

When soybeans are planted in corn and they reduce the corn yield 20 per cent or more, it may seem that it is poor economy to use them. However, if we consider the value of the bean hay or the value of the bean seed produced in addition to the value of the corn, a different picture is presented even for the first year the beans are grown. On the experiment station farm for the five years ending 1933, Otootan soybeans, when grown alone, yielded on the average 6179 pounds of air-dry hay per acre. The first year the corn and bean experiment mentioned above was run, the "corn alone" plots made 41.9 bushels per acre. Two acres, then, when the crops were grown separately made 41.9 bushels of corn and 6179 pounds of hay, or an average per acre of 20.9 bushels of corn and 3089 pounds of hay. The corn and beans together the first year the experiment was run made 33.9 bushels of corn and 4020 pounds of hay. This was a considerably better acre production of both corn and hay than where the two were grown separately. Later years after the beans had been grown on the land for a time, the margin in favor of the combination crop was even greater. Growing the beans on the land every year would evidently have a greater beneficial effect on the soil than when grown every other year in case a two-year rotation of corn and soybeans was used.

It may be suggested that if the corn and soybeans are grown together it is a difficult matter to save the soybean hay. It is true that it is more trouble to save the hay, but it is not such a hard task. After the corn grain has been gathered, the corn stalks and beans may all be mowed and put up for hay. The corn stalks add to the bulk considerably, but they furnish some additional feed. The corn may be cut and shocked and then the bean vines mowed if pure soybean hay is preferred.

Mooers (5) of the Tennessee Station reports results similar to the ones given above, except that he gives yields of soybean seed instead of hay. He found that as an average of six crops when Tokyo soybeans were grown alone, grown with corn, and corn grown alone, the corn alone produced an average of 49.9 bushels per acre; the beans alone, 25.9 bushels; the mixed crop yielded 32.3 bushels of corn and 17.1 bushels of beans per acre. The average acre yield for the two acres grown separately was 24.9 bushels of corn and 12.9 bushels of beans. For acre production this shows a decided margin in favor of the mixed crop. Other investigators have secured results similar to the ones given in the two experiments mentioned above. Considering these figures it seems that it is considerably more economical to grow the two crops together.

EFFECT OF SOYBEANS ON CORN YIELDS WHEN PLANTED IN THE SAME AND IN ALTERNATE ROWS

In some localities soybeans that are planted in corn are planted in rows alternating with the corn rows. When planted in this way, both the corn and beans are more easily harvested, but there may be some question as to whether or not this is the most profitable way to plant them. Akers and Westover (8) of the U.S.D.A. Forage Crop Field Station at West Point, Mississippi, tried planting corn alone, corn and Otootan soybeans in alternate rows, and Otootan soybeans alone. The corn alone made 23.5 bushels per acre; the corn in rows alternating with bean rows, 14.3 bushels. The beans in the rows alternating with the corn made 1.1 tons hay per acre, while the beans alone made 2.2 tons of hay. The spacing of the corn plants in the two methods of planting mentioned is not given, but probably the stalks stood the same distance apart in the two sets of rows.

Etheridge and Helm (4) of the Missouri Experiment Station found that corn alone, planted three stalks to the hill in check row hills 44 inches apart each way, yielded 37.8 bushels of corn per acre; that corn alone, with the same spacing in the row as just mentioned but with rows alternating with rows of soybeans, yielded 25.4 bushels of corn. The beans in this test when grown alone yielded at the rate of 14.1 bushels per acre; when grown in rows alternating with corn rows, 8.5 bushels. The two crops when planted separately gave an average yield of grain per acre, beans and corn, of 25.9 bushels. When they were planted together in alternate rows, the average acre yield of grain was 33.9 bushels.

Louisiana Experiments

The Louisiana experiments with corn and soybeans in the same row and in alternate rows were carried on on plots adjacent to the plots on which the experiments with "corn with and without soybeans" were conducted. Soil, fertilizer and weather conditions were about the same and the same varieties of corn and beans were used in the two experiments.

In the alternate row experiment, two sets of plots of four each were used. There were three rows of beans and three rows of corn in each plot of one set, and six rows of corn with beans in all of the rows in the other set. The same amount of seed corn or of soybeans that was planted in three rows in one case was planted in six rows in the other, and when thinning the corn, an effort was made to preserve the same ratio. However, in four cases out of five there were some more plants in the six-row plots of corn. The beans were not thinned. The plots were rotated every year, that is, land used for the alternate row plots one year was used for the "every row" plots the next.

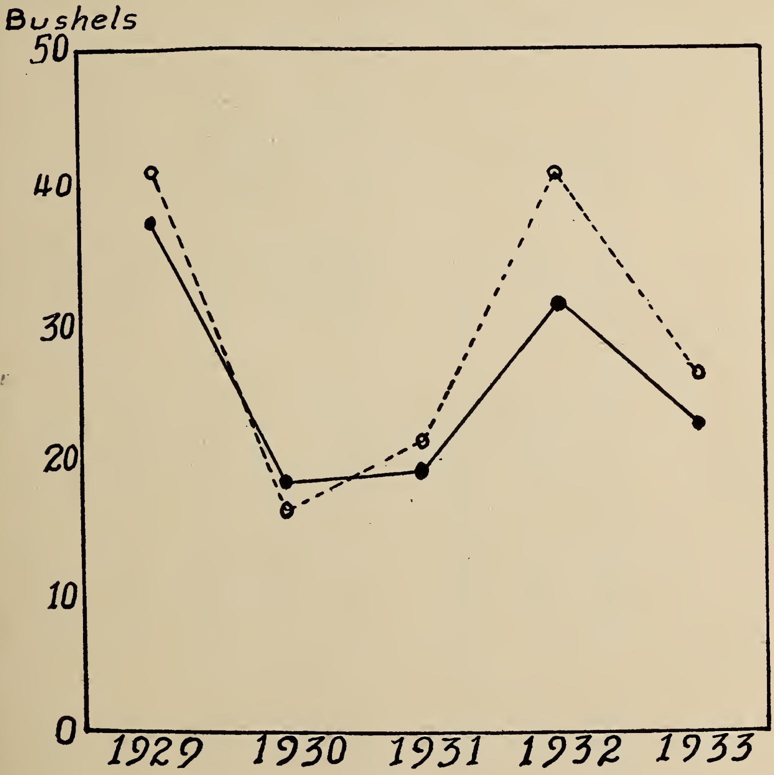

Fig. 5

Every row plots - - - - - - - - - - - Alternate row plots ————————

Figure 5 shows graphically the comparative yields in bushels of corn for the two sets of plots in the alternate row and "every row" experiment. The curves for both sets of plots are somewhat irregular due to variation in weather conditions different years, but they vary together. The weather in June during both 1930 and 1931 was too dry to be favorable for corn production. In 1933, a hail-storm damaged the corn considerably. Tables 3 and 4 give details of yields. In all cases the plot that had the larger number of corn plants led in yield of grain. In 1929 and 1930 the acre yields were computed on the basis of uniform stands. The difference was barely significant. In 1932, a year when corn made good yields, there was a considerable margin in favor of the "every row" planting. On the other hand in 1930, which was the driest year during the progress of the experiment, the alternate row planting made the most corn. Although the evidence is not very conclusive, it appears that under the less favorable conditions, the alternate row planting may be the most satisfactory. This accords with the views of farmers in poor land areas and in regions where droughts are common.

Table 3 gives the plot yields in pounds of ear corn for the five-year period and the acre yields in bushels. Since there was some difference in

TABLE 3. Corn and Soybeans in the Same and in Alternate Rows

Series	*Corn Grain Weights*								
	In alternate rows			*Both in the same row*					
			1929						
I	44.9	45.5	47.1	25.7	23.5	26.2	24.5	29.0	33.0
II	37.1	44.4	45.4	26.0	25.4	24.2	27.2	22.8	22.4
III	49.8	39.6	39.0	28.9	27.7	35.2	34.4	32.3	28.4
IV	51.5	48.0	49.5	29.8	29.5	33.6	31.5	33.2	27.7
Bushels per acre, basis equivalent stands			36.6	....	....	....	40.7	..	....
			1930						
I	20.6	22.0	28.3	6.8	10.6	14.2	9.4	7.1	8.5
II	27.0	24.3	24.3	9.4	7.5	9.6	10.8	10.9	10.7
III	18.1	20.2	26.5	9.0	9.3	6.1	7.2	10.2	9.0
IV	23.1	20.6	25.3	9.4	11.5	9.4	9.6	10.8	12.3
Bushels per acre			18.1	....	....	....	15.8	....	....
			1931						
I	25.0	25.1	28.1	15.7	15.3	11.5	13.5	15.9	10.1
II	20.8	22.4	29.2	12.8	11.6	13.3	13.1	15.1	13.0
III	20.7	25.7	32.0	16.4	11.8	12.0	14.5	14.1	13.7
IV	20.9	21.6	24.5	15.0	12.5	13.3	13.7	16.0	14.7
Bushels per acre			19.0	....	....	....	....	21.1	....
			1932						
I	26.3	28.0	30.2	17.5	15.5	19.5	16.4	17.5	18.6
II	31.6	33.1	30.1	15.4	14.6	16.4	17.3	13.8	15.1
III	23.3	24.7	26.1	19.3	20.2	18.2	19.0	18.5	19.8
IV	21.4	25.3	23.3	16.2	14.4	18.0	15.3	16.1	17.2
Bushels per acre			32.3	....	....	....	....	40.9	....
			1933						
I	33.4	34.7	....	21.0	16.0	16.9	14.5	....	....
II	22.9	20.8	....	15.7	12.8	13.0	14.0	....	....
III	22.9	20.2	....	13.5	14.1	12.0	13.7	....	....
IV	25.3	16.5	....	13.0	16.1	13.0	13.2	....	....
Bushels per acre			22.6	....	....	....	....	26.3	....

TABLE 4. SUMMARY OF DATA ON THE EFFECT OF PLANTING CORN AND SOYBEANS IN THE SAME AND IN ALTERNATE ROWS

Year	*Bushels corn alt. row plots*	*Bushels corn "every row" plots*	*Bean hay alternate row plots*	*Bean hay "every row" plots*	*Plants per row alt. row plots*	*Plants per row "every row" plots*	*Corn stover alt. row plots*	*Corn stover "every row" plots*
1929	36.6	40.7	3777 lbs.	3982 lbs.	66.6	39.5	....	....
1930	18.1	15.8	2971	3097	79.3	37.8	....	....
1931	19.1	21.1	....	....	63.0	42.8	....	....
1932	32.3	40.9	3025	2423	55.0	28.6	....	....
1933	22.6	26.3	1833	1956	83.0	44.5	8433 lbs.	10037 lbs.
Average	25.7	28.9	2803	2679	69.4	38.6	....	....

the number of stalks in plots that were compared, acre yields were computed on the basis of equivalent stands for some years.

The comparative difference in hay yields in table 3 is not great enough to be significant. However, if the matter of harvesting the hay is considered, there is some advantage in favor of the alternate row planting.

Weights of corn stover produced were taken only in 1933. This year there was a considerable margin in favor of the "every row" planting. Judging from the appearance of the corn in the plots, the every row plots probably had the greater weight every year.

Since the "every row" system of planting made considerably more stover per acre, this is doubtless the best to use in growing corn for the silo. The soybeans made slightly greater tonnage in the alternate rows, but the difference was not great enough to balance the loss in corn stover.

If we compare the alternate row planting with the "corn alone" and "beans alone" plots nearby, we find that the yields are better in the combination crop. The average yield of soybeans alone for a five-year period was 6449 pounds of dry hay per acre; the average yield of "corn alone" for the five-year period was 30.6 bushels. This is a yield of 3224 pounds of hay and 15.3 bushels of corn per acre. The combination crop during the same period of time gave an average of 25.7 bushels of corn and 2803 pounds of hay per acre.

Since the plots of the alternate and "every row" planting experiment were rotated each year, no difference in the residual effect was to be expected.

EFFECT OF RATE OF SOYBEAN SEEDING IN CORN ON THE PRODUCTION OF CORN GRAIN, CORN STOVER, AND SOYBEAN VINES

It is the general consensus of opinion that increasing the rate of seeding soybeans in corn will result in increased reduction of corn yields. Unfortunately not much study has been made of this question. Etheridge and Helm (4) of the Missouri Experiment Station found that with corn in hills 44 inches apart each way, three stalks of corn and one bean plant per hill gave a yield of 52 bushels of corn and 0.9 bushels of soybeans; three stalks of corn and two stalks of beans, 48.1 bushels of corn and 2.6 bushels of beans; three stalks of corn and three stalks of soybeans, 41.0 bushels of corn and 4.4 bushels of beans.

Odland (7) in West Virginia observed that with corn planted in hills 30 inches apart, two stalks of corn and one of soybeans in a hill gave a yield of 33.4 bushels of corn. With the same amount of corn and two bean plants to the hill, the yield was 33.1 bushels of corn per acre. This was an average of a five-year period. The difference is probably not significant.

Louisiana Experiments

The Louisiana experiments with the rate of seeding soybeans in corn were conducted under conditions similar to the other local experiments.

discussed previously, except that they were conducted on rather fertile Mississippi River alluvial land. Yellow Creole corn and Ototan soybeans were used. This variety of corn is similar to the variety used in the other tests, except for the color. A rate of seeding of 10, 15 and 20 pounds of beans per acre was used. The corn was in rows four feet apart and in hills 27 inches apart, two stalks to the hill. The beans were planted in the corn row when the corn was planted. The corn yields were considerably higher than the yields in the bench land tests previously discussed. This difference was due principally to the richer soil here. The soybeans also grew well, covering the ground in the middle completely.

Table 5 gives data on yields of the rate of seeding experiment for the five-year period that it was run. The corn stover weights were taken when the corn was ready for the silo. Soybean weights were taken at the same time. The corn grain weights were not taken until the ears were thoroughly dry.

TABLE 5. RATE OF SEEDING SOYBEANS IN CORN

Rate of seeding per acre	*Year*	*Bushels of corn per acre*	*Pounds of corn stover per acre*	*Pounds of soybean vines per acre*
10 pounds	1929	63.0	*	15,400
	1930	48.4		17,000
	1931	63.9	23,656	7,000
	1932	*	20,460	12,899
	1933	72.3	23,980	7,752
Average		61.9	22,699	12,010
15 pounds	1929	63.7		14,550
	1930	44.5		18,632
	1931	59.6	24,187	10,070
	1932		20,900	13,688
	1933	67.6	21,418	9,656
Average		58.8	22,168	13,315
20 pounds	1929	62.1		13,750
	1930	46.1		19,312
	1931	58.7	23,843	12,800
	1932		19,910	14,713
	1933	65.9	23,489	8,840
Average		58.2	22,414	13,883

* No corn stover weights were taken in 1929 and 1930. No corn grain weights were taken in 1932.

From the data given in table 5 it appears that the difference in rate of seeding was not sufficient to make any significant difference in corn yields or in yield of corn stover. Had the range in rate been greater, the land less fertile, or the supply of moisture more scanty, the difference in effect would doubtless have been greater. The difference in the rate of seeding the soybeans does appear to have had some effect on the weight of the soybean vines. This is in accord with expectations. An increase in the number of plants would naturally be followed by greater weight.

EFFECT OF SOYBEANS ON THE FOLLOWING CROP OF CORN WHEN THE BEANS ARE CUT FOR HAY OR WHEN PLOWED UNDER

A considerable amount of experimental work has been done to determine the effect of various legumes on the growth of the following crop when cut off for hay or when plowed under. Most of the work has been done with the clovers and alfalfa, but during recent years soybeans have been used considerably in the experiments.

Mooers (9) of the Tennessee Experiment Station obtained a yield of 27.1 bushels of corn per acre when the corn was grown continuously, a yield of 35.5 bushels where the corn followed a crop of beans that were removed for hay, and 39.7 bushels after the beans were turned under. These figures were an average from a six-year experiment.

In 1922 McClelland (10) at the Arkansas Experiment Station found that plowing under soybeans increased the yield of corn 12 per cent over removing for hay. In 1924 it gave an increase of 16 per cent.

Nelson (20) also of Arkansas in 1944 reported that on the basis of a ten-year average where bur clover was turned under the yield of the following crop of corn was 27.2 bushels per acre, but, if the top growth was removed, the corn yield was only 17.8 bushels.

Uhland (11) at the Missouri Experiment Station estimated from his experiments with soybeans that a crop turned under as green manure added about 70 pounds of nitrogen to the soil; when beans were cut for hay and manure returned to the soil, 30 pounds; when harvested for seed by use of a combine harvester (all plant parts returned except seed), there was a loss of about 4 pounds of nitrogen per acre; and when harvested for seed in the usual way (only roots and part of the leaves left on the land), a loss of about 28 pounds of nitrogen per acre.

At the Ohio Experiment Station, as mentioned by Morse (12), it was considered that the stubble and roots left after hay was removed had only 10 per cent of the weight of the hay and contained 6 pounds of nitrogen per acre. The hay removed contained 128 pounds of nitrogen.

From the figures given in the two cases just mentioned, it appears that if soybeans are cut for hay, they will not increase the fertility of the soil. In a number of cases it has been observed, however, that soybeans removed for hay did enrich the soil, as shown by increased yields of the following crop. Morse (12) mentions that at the Virginia Station wheat following a crop of soybeans that had been removed for hay gave an increase of 3.5 bushels per acre and when the entire crop of soybeans was turned under as green manure, a further increase of 6.6 bushels.

Andrews of the Mississippi Station found that when Otootan soybeans were grown in white sand in pots in a greenhouse, the roots weighed 23.4 per cent as much as the tops, and when grown in sandy loam soil under otherwise like conditions, the roots weighed 24.3 per cent of the tops. The percentage of nitrogen in the roots ran higher than in the tops in both cases. The percentage of roots obtained by

Andrews is higher than is ordinarily estimated but the writer is inclined to think that it is probably more nearly correct. If the plants are grown in pots, the whole root system is obtained, but if grown in a field, this is practically impossible.

A limited amount of study of soybean root systems in the soil has indicated to the writer that they are more extensive than is generally thought. Figure 6 shows a part of the root system of an Otootan soybean plant that we excavated. This plant was wide spaced so that the roots could be traced with a certainty. If other plants had been nearby, there would have been a mixing of root systems and confusion. The plant was grown on rather fertile alluvial land and attained a height of about four feet and a spread of approximately four feet. In the excavation only a part of the roots was traced out, although a hole "apparently" nearly large enough to bury a haystack was dug. Enough work was done to show that the root system was extensive, that it had a lateral spread of more than eight feet, and that some of the roots penetrated the soil to a depth of six feet. (The foot ruler shown by the plant stem in figure 6 will serve as a measure in judging the spread of the root system.) It seems certain that the total mass of roots, when the plant approaches maturity, is considerable. Probably an additional quantity of organic or chemical material, in the case of nitrogen, has been placed in the soil by the decay of root tubercles and tender parts of the roots during the growth period of the plant.

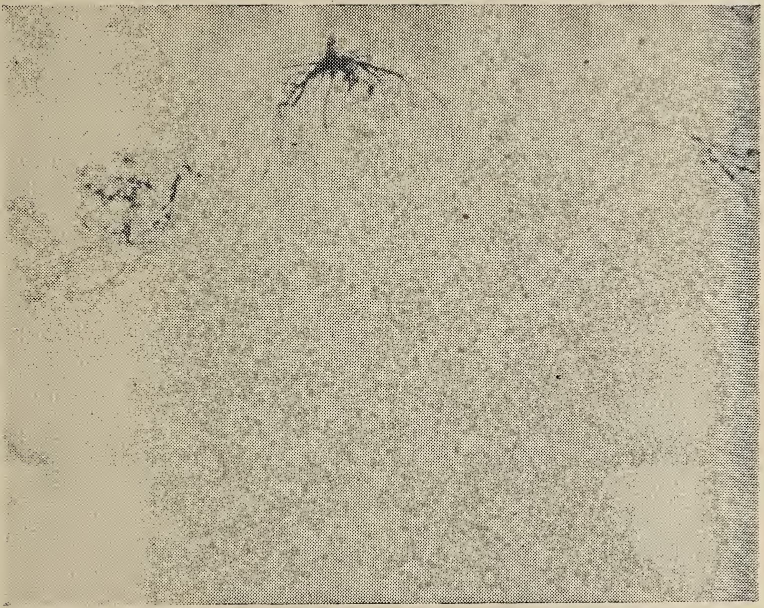

Fig. 6. Soybean root system.

TABLE 6. CORN YIELDS AFTER SOYBEANS WERE TURNED UNDER OR CUT FOR HAY

Series	*Plot weights of corn grain*								
	Plots with beans turned under			*Plots with beans cut for hay*			*Plots that grew no beans*		
				1930					
I	14.7	17.7	19.0	15.2	13.4	17.3	11.1	12.4	14.8
II	19.1	20.3	18.4	20.0	17.8	17.2	11.2	11.5	14.9
III	16.5	16.9	18.2	12.1	13.1	14.0	13.6	10.5	12.3
IV	25.5	25.2	24.5	15.5	14.3	16.9	14.2	12.2	13.8
Average No. plants per plot			56.0			53.8			51.3
Bushels per acre			30.5			24.1			19.6
Per cent gain from beans			55.6			22.9			
				1932					
I	34.7	32.1	35.3	25.3	21.1	22.8	15.2	19.3	20.2
II	32.5	31.5	34.1	26.7	19.2	26.5	9.4	11.0	11.8
III	29.5	28.5	28.1	15.1	15.2	15.2	10.0	9.0	11.5
IV	34.7	33.7	35.6	25.5	22.1	24.4	10.1	10.2	11.3
Average No. plants per plot			45.8			44.2			48.2
Bushels per acre			50.2			33.3			19.1
Per cent gain from beans			162.3			74.3			
				1934					
I	11.7	12.8	15.3	13.8	12.4	13.5	8.1	8.0	9.6
II	10.3	14.0	12.9	13.1	13.9	15.3	4.3	5.8	7.9
III	12.3	13.6	12.6	11.4	8.3	8.5	4.6	7.1	6.1
IV	16.2	13.2	18.8	14.5	13.7	13.7	7.2	5.5	8.1
Average No. plants per plot			45.1			47.0			43.3
Bushels per acre			21.0			19.5			10.6
Per cent gain from beans			98.1			83.9			

LOUISIANA EXPERIMENTS

The Louisiana experiments to determine the effect of soybeans on soil fertility when cut off for hay and when turned under were started on bench land soil in 1929. There were 20 one-row plots for each of three treatments. The general conditions of the experiment were about the same as outlined on the first pages of this bulletin. In 1929 one-third of the plots was planted in corn, while the rest was planted in Otootan soybeans; 4263 pounds of hay per acre were grown. The beans on one half of the bean plots were cut for hay and were turned under on the other half. In 1930 all the plots were planted in corn. The corn yields were used as measure of the soil fertility. In 1931 the plots that had been in beans were again planted in beans, and so on, a rotation being used each year. The corn plots that were used as a check were allowed to lie fallow in 1933.

Table 6 which follows gives the individual plot yields for the entire experiment, the average number of plants for each plot, the bushels of corn per acre for each treatment and the percentage of gain in yield for the different treatments. In 1934 the yields were reduced on all the plots by the tropical storm on June 16 which damaged the plants. The number of mature corn plants per plot averaged very nearly the same if the whole period of the experiment is considered. The figures ran as follows: plots with beans turned under, 48.9; plots with beans cut for hay, 48.3; plots without beans, 47.6.

The data given in table 6 show unusual benefit from the growing of soybeans as a means of increasing soil fertility. The percentage of gains, especially on the plots where the beans were cut off for hay, is greater than most investigators have obtained in similar experiments. Why this was true is not easily explained. The results seem to be reliable, for the land used was fairly uniform, several replications were used, and the number of corn plants per plot, considering the whole period of time, was as nearly uniform as any one could ever hope to have in an experiment of this type. The difference was not due to the reduction in fertility of the check plot, because there was not much lowering in yield. The drop in 1934 was due to the storm mentioned previously and affected all the plots alike.

EFFECT OF INTERPLANTING DIFFERENT SUMMER LEGUMES IN CORN

For a number of years soybeans have been used rather generally in south Louisiana for interplanting in corn to improve soil fertility and to lessen the growth of grass and weeds in the corn after it is laid by. They have been found to be unsatisfactory in certain ways for this purpose. If planted in the corn row when the corn is planted, they may act like weeds and compete with the corn plants for available moisture and plant nutrients, thus reducing the corn yields, as was shown on other pages of this bulletin. This harmful effect is worse during dry years and on poor lands. In south Louisiana, too, leaf-eating caterpillars, *Anticarsia* *gemmatilis,* unless controlled with poison, usually strip the soybean plants of leaves and stop their growth and fruiting.

A limited number of experiments have been conducted to determine the best legume to plant in corn and the best time and method of planting. McClelland (19) of Arkansas planted cowpeas, soybeans, velvet beans, and mung beans in corn as follows: (a) early in the rows, (b) at medium date in 58-inch middles, and (c) when laying by in 44-inch middles. The legume growth varied directly with the time of seeding, the earliest being best. Competition and shading by the corn made planting at lay-by time unsatisfactory. The current corn yields were best where bean growth was lightest. The experimenter concluded that the soybean was superior and the mung bean inferior to the other legumes used for interplanting in corn.

Kuykendall (15) in the Yazoo-Mississippi Delta, as was mentioned previously, failed to get reduction in yields in corn from interplanting soybeans and Crotalaria at corn planting time the first year. These legumes, and cowpeas as well, more than doubled the corn yields the second year. The legumes when interplanted with corn at lay-by time made poor growth and gave lower increases.

Other work by Hackleman (1), Thatcher (2), Kinney (3), Etheridge and Helm (4), Mooers (5) and Ayres (6) on the effect of soybeans and other legumes interplanted with corn is discussed on other pages of this bulletin.

LOUISIANA EXPERIMENTS

In 1937 some preliminary work was started at the Louisiana Experiment Station to determine the relative value of several different summer legumes for interplanting with corn. The first year all the legumes were planted in the row of corn when the corn was planted. It was found that the cowpeas and velvet beans were not satisfactory for this type of planting for if planted with the corn the vines made such rank growth that they pulled the corn stalks down, causing the ears of corn to touch the ground and rot more or less. The Crotalaria (*Crotalaria spectabilis*), coffee-weed (*Sesban macrocarpa*), and patridge-pea (*Chamaecrista chamaecristoides*) were unsatisfactory because they all had very small seeds and the young plants were so small and made such slow growth that the corn could not be cultivated satisfactorily without covering them with soil. Since it was necessary to change the location of the plots each year the first two years, no data were secured on the effect of the different legumes used on soil fertility.

In 1939 some changes were made in the project. Bunch velvet beans were substituted for the viney type and they and the soybeans were planted in the corn rows when the corn was planted. Cowpeas, Crotalaria and coffee-weed were planted in the row middles at lay-by time for the corn. One set of plots was left without legume or treatment, one set was given an application of 150 pounds of nitrate of soda per acre annually and another set planted with Austrian winter peas or vetch each winter.

This latter was used so that comparison could be made of the relative value of a winter legume and the various summer legumes.

Cocke Prolific corn was used throughout the experiment, planted in rows four feet apart and thinned to one stalk every 27 inches. In the case of the soybeans and velvet beans a hill of the legume was planted between hills of corn. Four row plots were used with four replications of each treatment.

A good stand and good growth of the winter legume was had each year of the six years of the experiment, producing 4 to 5 tons of green matter per acre for turning under. The coffee-weeds made numerous large plants but stands were not very uniform and plants were spreading and limby. The total tonnage of vegetative matter was not so great. The Crotalaria seed planted gave excellent stands and the growth of plants was good, producing probably twice the weight of green matter of any of the other legumes. This, however, was very succulent and contained much water. Results seemed to show that it contained less nitrogen per plot than some of the other legumes. A liberal sowing of cowpea seed was made in the middles each year at the lay-by time of the corn. The peas germinated well, but after the young plants attained a height of about six inches they began to shed their leaves and many died. The shade and competition offered by the corn plants affected them adversely apparently. Production results show that fertilizing value of the cowpeas as grown was low. Some trouble was had certain years in getting a good stand of the bunch velvet beans and their growth was only fair. However, their fertilizing value, as shown by the corn yields, was relatively good. The soybeans gave fairly good stands each year, but there was considerable variation in the growth from year to year, ranging from one to two tons of dry hay per acre.

As was mentioned on a previous page, the soil on which this cultural experiment was conducted was lacking in uniformity but was the best available at the time. There was considerable difference in corn yields different years due to seasonal effect and soil differences came out more strikingly on poor corn years. At two times during the course of the experiments all the plots were under water due to floods. This probably served to equalize the effect of the different treatments to some extent.

Table 7 gives relative corn yields for the six years that the experiment was conducted on the same land. The yields vary considerably different years due to seasonal effects but are fairly consistent. The year 1944 was an especially poor corn year because there was too much rain early in the season and not enough later. The corn following Austrian winter peas, Crotalaria, velvet beans, and nitrate of soda gave significantly higher yields than the check, a difference of 3.9 bushels per acre being required for significance. The yields for 1939, the first year of the experiment, are not included in the five-year average due to the fact that the effect of the legumes on soil fertility could not show the first year.

The yield results shown in table 7 indicate that all the legumes used are helpful to some extent in increasing corn yields and that the differences between them are not great. The nitrate of soda at the rate used resulted in slightly greater production than any of the other treatments. The cost of this treatment was somewhat greater than that of any of the others and probably the residual effect not as great. The residue from the legumes added more organic matter to the soil and the nitrogen contained was given up more slowly. Plots that had grown Austrian winter peas ranked second best on the average and were first two years. Although this is not a summer legume, it may be compared with them in value and it ranks high. It requires some more labor to plant this crop but it adds nitrogen and organic matter to the soil, occupies the land when it does not interfere with another crop and serves as a good winter cover crop to lessen erosion. The Crotalaria plots ranked third in corn yield. This legume seems to be valuable in most ways but is objectionable in that the forage is poisonous to stock. The velvet bean plots ranked fourth in yields. The forage of this plant adds nitrogen and organic matter to the soil and furnishes considerable good winter pasturage to livestock, especially to cattle. The coffee-weed adds considerable organic matter to the soil and apparently some nitrogen, but its plants are of no value for winter forage and the numerous seeds produced germinate fairly early in the season and give considerable annoyance as weeds in the corn. The soybeans, as has been mentioned previously, compete with the corn plants and, in south Louisiana, are very commonly largely destroyed by leaf-eating caterpillars. Cowpeas when planted in corn at corn lay-by time do not injure the corn appreciably and in some areas make good growth and add much nitrogen and organic matter to the soil, but in south Louisiana, under conditions such as prevail at Baton Rouge, they are unsatisfactory for this purpose.

TABLE 7. CORN YIELDS AS AFFECTED BY THE INTERPLANTING OF DIFFERENT LEGUMES

	Bushels per acre						
	1939	1940	1941	1942	1943	1944	*5-year average**
Corn alone, Austrian winter peas in winter	20.4	42.0	33.2	36.4	50.3	30.3	38.4
Coffee-weeds at lay-by time	19.4	29.1	27.8	40.5	52.3	27.3	35.4
Crotalaria at lay-by time	19.4	36.1	28.4	41.0	51.3	29.1	37.2
Cowpeas at lay-by time	20.4	33.4	26.8	30.7	55.4	25.7	34.4
Soybeans at planting time	13.9	37.9	27.6	37.6	47.2	21.6	34.4
Velvet beans at planting time	17.7	34.2	34.2	39.4	50.3	25.7	36.8
150 lbs. nitrate of soda	24.0	35.4	36.3	43.6	59.3	29.1	40.7
Check, no treatment	19.1	34.7	25.8	32.6	45.3	18.5	31.4

* A difference of 3.9 bushels per acre is required for significance.

EFFECT OF CERTAIN WINTER LEGUMES ON CORN YIELDS WHEN USED AS VOLUNTEER WINTER COVER CROPS

The object of this experiment was to find a winter-growing legume that would serve as a good cover crop, add a liberal quantity of nitrogen and organic matter to the soil and ripen a crop of seed in time for turning under prior to corn planting. Some legumes when grown in this way may produce enough good seed to reseed themselves and thus serve as a volunteer crop.

A brief review of crop culture literature seems to indicate that there has not been very much experimental work done to determine the value or feasibility of using volunteer winter legume cover crops. McKee and McNair (21) have expressed the opinion that they will not be a success in many places due to the fact that most winter legumes do not mature seed under Cotton Belt conditions and ones that do do not have enough hard seed to carry over and give a good volunteer stand the following year. Bur clover, narrow-leaf and hairy vetch are mentioned as being the best for this purpose.

Experimental work on the project was started at Baton Rouge in the autumn of 1940. Branch bottom land of Olivier silt loam soil was used. This land had been cultivated for many years and was not very fertile or uniform. Three hundred pounds of a 2-14-6 fertilizer were applied ahead of the corn planting each year. In 1940 the legume seed were sown on one row, four-foot wide, beds on October 20. The soil was well pulverized and good stands were had on all plots. The kinds of legumes and other treatments used are shown in table 8. On account of the small size of the cuts of land used it was necessary to plant in two different cuts the first year. Check plots were used on each cut. The performance of the legume should be compared with the check plot in the same cut.

With the exception of sour clover (*Melilotus Indica*) and the wild vetch, all the legumes made fair to good growth during the winter of 1940-41. Although the land used was branch bottom land it apparently was too acid for the sour clover to make satisfactory growth. An application of a ton of hydrated lime per acre was made on the plots prior to the second year. This improved the growth considerably.

During the first year the crimson clover plots produced excellent growth (about 6 tons green weight per acre) and a good crop of seed, but the seed were only partly ripe on May 16 when the crop was turned under. The land was pulverized well and corn was planted May 24. The weather being seasonable and the ground in good shape, the corn plants soon emerged and made rapid growth. But the planting date was too late for good quality and high yields of corn. Leaf rust was severe on the plants during June and July, reducing yields and making most of the ears rather light and chaffy.

The hop clover (*Trifolium dubium*) made a fair growth late in the season—about two tons of green matter per acre—and an abundance of seed. The seed were ready to turn under by May 15.

The sour clover, as was stated above, made poor growth the first year, not more than one-half ton per acre green weight and only a few seed. After liming the land the plots were reseeded the second year and better growth was secured.

The creole peas (*Lathyrus sativus*) came up soon after planting and made good vegetative growth during the late fall and early winter. The plants bloomed considerably but set only a few seed. The plants died down early in March. There were about three tons of green matter when the plants were at their prime.

The Singletary peas (*Lathyrus pusillus*) made rather feeble growth during the fall and winter but made heavy growth during April and May. All the ground of the plots was covered to a depth of 18 to 24 inches, making about six tons of green matter per acre. Many seeds were produced but they did not start ripening until about the middle of May, thus making the crop late for turning under ahead of corn.

The giant bur clover (*Medicago Arabica*) made a heavy growth during the winter, about six tons per acre, and an abundance of seed during the late winter and early spring. Seed ripened prior to April 15.

The Augusta, or narrow-leaf vetch (*Vicia angustifolia*) made excellent late winter growth—six tons per acre—and ripened a good crop of seed by April 20.

The local wild vetch (*Vicia ludoviciana*) made but feeble growth during the winter and spring and made practically no seed. This was rather surprising because along fence rows and in vacant lots where there were numerous other plants growing it had been observed to be making good growth apparently and producing an abundance of seed; but in the open field where it had no competition, it did poorly. It is very evident that it is not suitable for field planting.

The corn following the legumes mentioned above was gathered about the middle of September and stalks turned under on September 22. This rebedding brought the legume seed that had been turned under in the spring near the surface so they might germinate. On November 1 there were fair stands of crimson and bur clovers and a few vetch plants were appearing. Volunteer plants continued to come up until in a few weeks there was a good stand of crimson clover, hop clover, bur clover, and Singletary pea. The creole pea and the wild vetch plots produced no volunteer plants and the narrow-leaf vetch but very few. The latter was somewhat surprising since this vetch produced an abundance of seed and they matured early.

It seemed evident from one year's trial that the creole peas, wild vetch, and narrow-leaf vetch were not adapted to serve as a volunteer cover crop ahead of corn so they were discontinued after the first year. The other legumes were continued for a four-year period following about the same methods of procedure as were given for 1940-41. Kudzu was set out on the creole pea plots the second year of the experiment, but the plants had not become well enough established to plow under to use in a rotation with corn before the experiment was terminated. The legumes that were continued made growth the following years similar to the growth made the first two years. There was some tendency for the seed to become scattered and a limited number of volunteer plants appeared on all plots. After the second year mildew appeared on the leaves of many of the plants of the hop clover. This lessened vegetative growth and seed production. During the third year of the experiment another fungous disease, anthracnose, attacked some of the bur clover plants. During the fourth year this disease was so severe that it killed the majority of the plants before they produced a full crop of seed. This increase in diseases gives evidence that it is not advisable to attempt to grow the same legume on a piece of land many years in succession.

Table 8 gives the corn grain yields following the volunteer winter legumes during four years that the experiment was run.

TABLE 8. CORN YIELDS FOLLOWING VOLUNTEER WINTER LEGUMES

	Bushels per acre				
	1941	1942	1943	1944	*4-year average*
1. Crimson clover	37.0	32.7	27.9	24.1	30.4
2. Hop clover	32.7	27.9	29.0	19.8	27.4
3. Sour clover	34.8	23.8	27.4	30.1	29.0
4. Creole peas	37.9	No volunteer peas came up so land was planted in kudzu after 1st year.			
5. Singletary pea	35.9	31.0	27.0	22.0	28.9
6. Giant bur clover	38.3	31.8	29.5	23.4	30.8
7. Check, no treatment	30.5	20.4	22.0	14.7	21.9
8. 150 lbs. nitrate of soda yearly	34.6	25.4	24.1	16.0	25.0
9. Narrow-leaf vetch	28.5	Discontinued after first year.			
10. Local wild vetch	No corn planted due to the failure of the vetch.				
11. Check, no treatment	19.4				

The corn yields given in table 8 indicate that all the legumes used effected significantly greater yields than the no treatment check, and all of the ones used in the main test, with the exception of one treatment one year, resulted in better corn yields than the use of 150 pounds of nitrate of soda. Corn yields following bur and crimson clover were the best but the differences in the effect of the different legumes were not great and probably not significant.

It is of some interest to note that 150 pounds of nitrate of soda in the summer legume experiment, table 7, was instrumental in producing more corn than any of the legumes used, while in the winter legume experiment, table 8, it produced less than the legumes. The two experiments were conducted in the same field, the same variety of corn used, and the years were identical for four years. The main difference was in the date of planting, the summer legume cut being planted a month to six weeks earlier most years.

The legumes used caused corn increases from 5.5 to 8.9 bushels per acre. This was enough increase for them to be profitable because there was little expense connected with this type of culture—the cost of the seed and expense of planting the first crop being about all. In addition to the corn yields mentioned there was doubtless also some soil improvement that would show in the crop the following year. This would probably be striking on a following crop of corn if planted earlier.

The main objections to the use of volunteer legumes as handled is in the length of time required to mature the legume seed. If the plants are let stand until a fair crop of seed is matured, the corn is apt to be too late for good quality and good yields. In the vicinity of Baton Rouge, late corn is very commonly badly damaged by leaf rust. Of the legumes tried, bur clover was the best and crimson clover next. But on account of fungous diseases, it is best not to grow them continuously on the same land for more than three years.

SUMMARY

1. The corn and soybean experiments discussed were conducted under rather humid conditions and on moderately fertile soil.

2. Cocke Prolific corn and Ototan soybeans, or similar varieties, were used in the tests. They are vigorous, rank-growing varieties.

3. The soybeans planted in the row of corn when the corn was planted invariably made good growth. They lowered the corn grain yield 19.1 per cent the first year, 33.6 per cent the second, but increased it 12.7 per cent the third, 51.7 per cent the fourth, and 35.2 per cent the fifth.

4. The soybeans grown in the corn plots just mentioned gave an average yield of 3108 pounds of dry soybean hay per acre.

5. The soybeans decreased the weight of corn stover the first years of the experiment but increased it the later years. In 1933, the last year, there was an increase of 31.8 per cent.

6. The soybeans grown in corn on the land for four years increased the amount of organic matter in the soil 0.176 per cent, and the total nitrogen present, 0.0088 per cent.

7. If both corn and soybeans are to be grown, it is more economical to grow them both on the same land rather than on separate acres. When grown separately, the average production per acre was 20 bushels of corn and 3089 pounds of dry bean hay, but when grown in combination, the production per acre was 33.9 bushels of corn and 4020 pounds of hay.

8. With the same number of stalks per acre (both corn and soybeans) there was but little difference in yield between alternate row and "every row" planting. The differences were hardly significant most years. Under very favorable conditions for growing corn, the "every row" planting appears to give the best results, while under unfavorable conditions, the alternate row plan seemed to be best.

9. Alternate row planting is better for harvesting both the corn and the hay.

10. Varying the rate of soybean seeding in corn gave no consistent difference in corn production, either grain or stover, but an increase in rate of seeding did increase the weight of soybean hay produced. Rates of 10, 15, and 20 pounds of soybeans per acre were used.

11. Turning under soybeans, on plots where they were grown alone, increased the corn production the following year by 55.6 per cent; 162.3 per cent at the end of the second rotation, and 98.1 per cent at the end of the third.

12. Plots on which the soybeans were grown alone and cut for hay gave an increase in corn yields the following year of 22.9 per cent; an increase of 74.3 per cent the fourth year, the end of the second rotation, and an increase of 83.9 per cent at the end of the third rotation.

13. A search was made for a summer legume more satisfactory than soybeans for interplanting in corn. Plants tried were coffee-weeds planted at corn lay-by time, Crotalaria planted at lay-by time, soybeans at corn planting time, and velvet beans at corn planting time. Austrian winter peas, grown during the winter, 150 pounds nitrate of soda per acre, and no treatment were used as comparative checks.

14. All the legumes and treatments used increased the corn yields. Nitrate of soda was best, Austrian winter peas second best, Crotalaria third and velvet beans fourth. The cowpeas died prematurely and leaf-eating caterpillars stripped the soybean plants most years.

15. In a winter legume experiment an effort was made to find a legume that would make good winter growth in south Louisiana and ripen enough seed prior to corn planting time to reproduce itself. In the experiment the following legumes and treatments were tried: crimson clover, hop clover, sour clover, creole peas, Singletary peas, giant bur clover, narrow-leaf vetch, a local wild vetch and 150 pounds of nitrate of soda per acre.

16. One year's trial showed the creole peas, local wild vetch and narrow-leaf vetch to be unsatisfactory for the purposes sought. The other legumes and treatments all gave increases in corn yields, the amounts ranging from 3.1 to 8.9 bushels per acre. Bur clover gave the best increase and crimson clover next. Nitrate of soda used at the rate of 150 pounds per acre gave lower yields than any of the other treatments.

17. The main drawback to the use of volunteer winter legumes is that most of them have to be let stand until late in the spring to ripen seed. This makes the corn too late for best quality and highest yields.

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FARM OWNERSHIP IN LOUISIANA FINANCED UNDER THE BANKHEAD-JONES FARM TENANT ACT

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FARM OWNERSHIP IN LOUISIANA FINANCED UNDER THE BANKHEAD-JONES FARM TENANT ACT

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INTRODUCTION

There is widespread interest in the Federal program for helping farm tenants advance to ownership as provided for under Title I of the Bankhead-Jones Farm Tenant Act. This act was approved in July 1937, and authorizes government loans to worthy farm tenants, laborers and sharecroppers for the purpose of enabling them to acquire farms. The program provided for in this title is commonly known as the Tenant Purchase Program, and is administered by the Farm Security Administration under the general direction of the United States Department of Agriculture. Only citizens of the United States are eligible for loans, and preference is to be given those who are able to make a down payment, or who are owners of the livestock and the equipment necessary to operate a farm, and to persons who have dependent families.[1] During the period from 1937 to January 1, 1945, 1,452 loans were made to applicants in Louisiana to enable them to buy land and make the improvements needed. By the same date, 43 of these borrowers had repaid their loans in full. The distribution of the loans made by parishes is shown in Figure 1.

Loans are authorized for the purpose of enabling approved applicants to buy farms, to make necessary repairs to buildings or to build new ones, and to make the land improvements needed. Farms accepted as security for loans, are required to be of such size as to constitute an efficient family-type farm, but in June 1940, the law was amended to provide that the price paid for any farm cannot exceed the average value of all farms of 30 or more acres in the county in which it is located.[2] In no case can the total loan be more than $12,000.[3]

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*The author wishes to acknowledge the helpful assistance given in planning this study and throughout the development of the manuscript by Professor B. M. Gile, Head of the Department of Agricultural Economics.

[1] "Title I, Farm Tenant Provisions," *Bankhead-Jones Farm Tenant Act,* Public No. 210, 75th Congress, Chapter 517, 1st Session, H. R. 7562, Section 1, p. 1.

[2] *United States Statutes at Large,* 76th Congress, 2nd and 3rd Sessions, 1939-1941, Volume 54, Part I, Public Laws, Reorganization Plans, Chapter 421, p. 564.

[3] United States Department of Agriculture, *Farm Purchase Loans,* Farm Security Administration, Washington, July 1944, FSA Publication 130 (Revised).

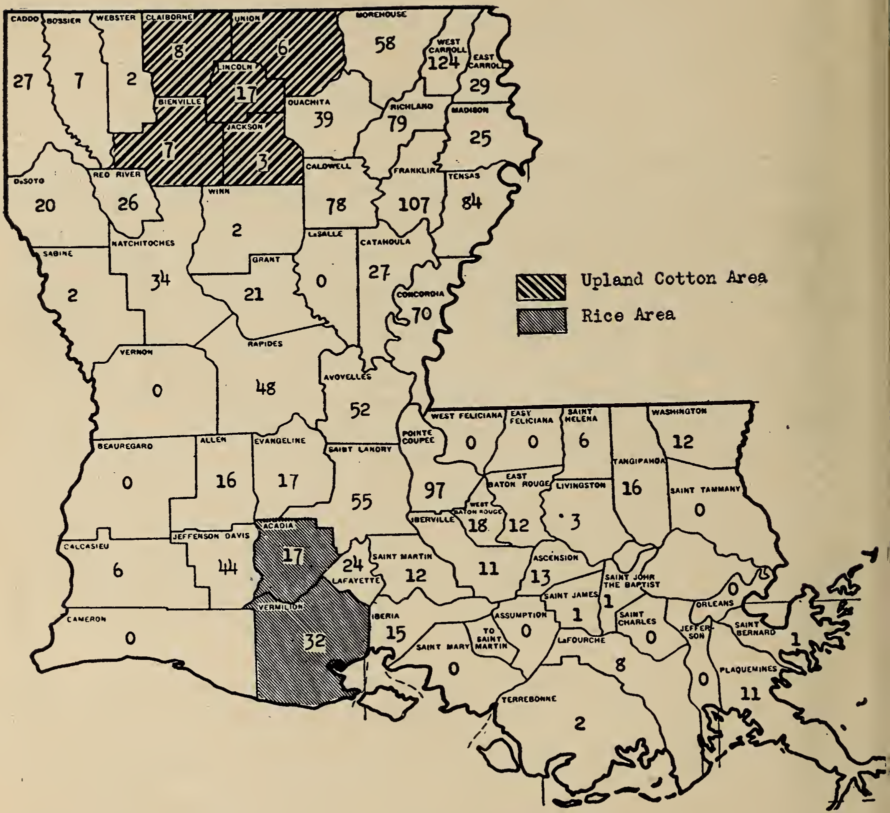

Figure 1. Location of the two areas surveyed and the number of tenant purchase farms by parishes, Louisiana, January 1, 1945

Committees composed of local farmers have been set up "in each county in which activities are carried on" to determine the eligibility of applicants for loans and to certify to the Secretary of Agriculture those approved to receive them. In examining the applicants, investigations are made of their character, ability, and experience. It is also the duty of the committee to appraise each farm proposed for purchase and to certify to the amount which in its judgment is a reasonable value.[4]

The rate of interest on tenant purchase loans is three percent and the loans are to be amortized over a period of 40 years.[5] During the early years of operation, the regulations provided for two methods of repayment; known as the fixed payment plan and the variable payment plan. Each borrower was allowed to choose the method he desired for retiring his indebtedness. Under the fixed payment plan the borrower would be expected to pay 4.326 percent of the original loan each year. This rate of annual payment covers both interest and principal and will free the farm of debt in 40 years. Under the variable payment plan, the borrower would make payments according to his net cash income; that is, in years of high returns he would pay more than in years of low return.[6] In 1941, the regulations were revised to require all future borrowers to accept the variable payment plan. However, the Farm Security Administration reserves the right to transfer a borrower to the fixed payment plan, if his records are found to be too incomplete or inaccurate to determine his net cash income, or if he fails to pay the amount requested. A borrower may also be transferred to the fixed plan, if for two or more years, he falls behind schedule 20 percent more than the average for all borrowers in his county.[7]

The advantage of the variable payment plan is that the amount to be paid is based upon the net farm income; that is, income left after cash operating expenses and necessary family living expenses are deducted from gross cash income. This means that in years of low farm income, due either to poor yields, low prices, or both, the family could continue to live without becoming delinquent and in danger of losing its farm.

NATURE OF STUDY AND SOURCES OF INFORMATION

This report has to do with farms purchased in the rice and upland cotton areas of Louisiana under Title I of the Bankhead-Jones Farm Tenant Act.[8] It deals primarily with: (1) the number, size, and cost of farms acquired; (2) the amount of credit extended for the purchase of farms and their improvements in relation to total land and improvement costs; (3) the characteristics of the farmers to whom loans have been granted; and (4) the approximate amount of capital required to own and operate a family-size farm in the rice and upland cotton areas during the period under consideration.

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[4] Bankhead-Jones Farm Tenant Act, *op. cit.*, Section 2, pp. 1-2 and Section 42, p. 9.

[5] *Ibid.*, Section 3, p. 2.

[6] United States Department of Agriculture, *Farm Tenant Loans*, Farm Security Administration, Washington, D. C.

[7] United States Department of Agriculture, *Explanation of Variable Plan For Repaying Tenant Purchase Loan*, Farm Security Administration, Washington, D. C., Form FSA 364, June 1941.

[8] It is anticipated that studies will be made later of other important areas.

Most of the data presented in this report were obtained from farmers living in 1943 on farms purchased with the assistance of loans extended under Title I of the Bankhead-Jones Farm Tenant Act and from the records of the Farm Security Administration.[9] Other sources of information are acknowledged in appropriate footnotes. All the farmers having FSA land purchase loans and operating farms as owners in 1943 in the parishes included in the survey were interviewed. There were 37 of these owners in the upland cotton area and 40 in the rice area. The distribution of these farms by parishes and by color of the operator is shown in Table 1.

TABLE 1. TENANT PURCHASE BORROWERS OPERATING FARMS AS OWNERS, TWO AREAS, LOUISIANA, 1943

Area and parish	*Tenant purchase borrowers*		
	White Number	*Negro Number*	*Total Number*
Upland cotton:			
Bienville	5	2	7
Claiborne	7	1	8
Jackson	2	1	3
Lincoln	9	5	14
Union	4	1	5
Sub-total	27	10	37
Rice:			
Acadia	16	1	17
Vermilion	22	1	23
Sub-total	38	2	40
Grand Total	65	12	77

Forty-six farms had been bought in the rice area but only 40 loans were closed in time for the farms to be operated in 1943 under the program (Appendix Table 1). Six of the original borrowers in the upland cotton area were not operating the land purchase farms in 1943. Five of them had abandoned their units prior to January 1, 1943 and the other one shortly thereafter. Four of these owners had been replaced, but one of the replacement farmers had moved from the farm prior to January 1. Therefore, three of the units were not owner-operated in 1943.[10] In addition to the visits made to the 1943 owner-operators, four of the previous owners were contacted and interviewed with regard to reasons for leaving their farms.

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[9] For convenience, loans under Title I of the Bankhead-Jones Farm Tenant Act will be referred to hereafter in this report as FSA land loans.

[10] Data obtained from FSA records.

SIZE OF FARMS PURCHASED

The average size of the farms purchased in the upland cotton area was 100 acres and in the rice area 135 acres. In the cotton area, the farms varied in size from 60 to 160 acres, and in the rice area from 37 to 269 acres. At the time of purchase, the average amount of cropland was 54 and 122 acres in the two areas, respectively. Twenty-two of the farms in the cotton area, or 55 percent, had less than 100 acres, while only six or 15 percent contained 140 or more acres (Table 2). Eleven of the cotton farms were 80 acre units, and this was the most common size. The cropland on the cotton farms at the time of purchase varied from 30 to 100 acres, and averaged 54 percent of the total area of the farms.

TABLE 2. SIZE OF FARMS PURCHASED WITH TENANT PURCHASE LOANS, TWO AREAS, LOUISIANA

Size of farms	*Distribution according to size*			
	Upland cotton area		*Rice area*	
	Number	*Percent*	*Number*	*Percent*
Less than 60	0	0.0	5	12.5
60- 79.9	6	15.0	4	10.0
80- 99.9	16	40.0	7	17.5
100-119.9	8	20.0	3	7.5
120-139.9	4	10.0	3	7.5
140-159.9	5	12.5	3	7.5
160-179.9	1	2.5	3	7.5
180-199.9	0	0.0	3	7.5
200 and over	0	0.0	9	22.5
Total	40[1]	100.0	40	100.0

[1] Includes 37 farms that were owner-operated in 1943 and three that were tenant operated.

Eighteen of the farms in the rice area, or 45 percent, were units of 140 or more acres, while 40 percent were less than 100 acres in size (Table 2). Although the farms selected for study in the rice area were located in two of the leading rice-producing counties, it was found that sugarcane was the main cash crop on 10 of them. The average size of the ten farms growing sugarcane was 63 acres while the average size of 22 farms on which rice was the only cash crop reported was 172 acres. The units in the former group ranged in size from 37 to 91 acres and those in the latter group from 82 to 269 acres. An average of 90 percent of the total acreage of the farms in the rice area was in cropland.

PRICES PAID FOR FARMS AND COST OF IMPROVEMENTS

The average amount paid to the former owners for farms in the upland cotton area averaged $1,864 and in the rice area $5,856. The range in the purchase prices was from $959 to $3,100 and from $2,000 to $10,980 in the two areas, respectively. In the cotton area 27 of the farms or 67.5 percent cost $1,900 or less, while only 3 or 7.5 percent cost more than $2,900. In the rice area 55.0 percent cost more than $4,900 (Table 3). In addition to the amounts paid to the former owners for farms, the borrowers were required to pay certain acquisition fees which averaged $24 in the cotton area and $29 in the rice area. These acquisition expenses consisted of certain title insurance costs, charges incidental to filing and recording deeds and mortgages and other miscellaneous charges.

Land purchase loans ordinarily include funds for buildings and improvements. A careful study of each farm is made by FSA officials and the applicant, after which an agreement is reached on the improvements necessary to provide adequate housing for the family, and the buildings, fences, and land improvements needed for efficient operation of the farm. On 30 farms in each area on which the major improvements agreed upon had been completed, the average cost of these was $1,907 in the cotton area and $2,781 in the rice area (Table 4). The cost on individual units varied from $815 to $2,380 in the former area and from $1,334 to $5,131 in the latter area. Probably more of the owners would have had the improvements on their farms completed, if the war had not interfered.

TABLE 3. AMOUNTS PAID TO FORMER OWNERS FOR TENANT PURCHASE UNITS, UPLAND COTTON AND RICE AREAS, LOUISIANA[1]

Amount paid	*Distribution of farms*			
	Upland cotton area		*Rice area*	
Dollars	*Number*	*Percent*	*Number*	*Percent*
901 - 1900	27	67.5	0	0.0
1901 - 2900	10	25.0	2	5.0
2901 - 3900	3	7.5	8	20.0
3901 - 4900	0	0.0	8	20.0
4901 - 5900	0	0.0	3	7.5
5901 - 6900	0	0.0	6	15.0
6901 - 7900	0	0.0	5	12.5
7901 - 8900	0	0.0	2	5.0
8901 - 9900	0	0.0	4	10.0
Over 9900	0	0.0	2	5.0
Total	40	100.0	40	100.0

[1] Includes all those that had been operated under the program prior to January 1, 1944.

New dwellings had been erected on 26 of the cotton farms and on 27 of the rice farms. On the remaining units in both areas the houses were such that they could be repaired. The average cost of the new dwellings in the cotton area was $1,358 and in the rice area, $1,893. The cost of new dwellings ranged from $930 to $1,590, and from $1,335 to $4,226 in the two areas, respectively. The houses in the rice area generally cost more than those in the cotton area, because they were larger, better quality materials were used, and they had more conveniences.

Outbuildings to meet the needs of the operators were provided on all the farms. If the barns existing at the time of purchases were inadequate, they were either repaired or replaced. The average cost of new and repaired barns was $357 in the cotton area and $400 in the rice area (Table 4). Other buildings consisted of poultry houses, smokehouses, garages, and sanitary toilets. The average cost of these other buildings was $87 in the cotton area and $156 in the rice area (Table 4).

TABLE 4. Cost of Real Estate, 60 Tenant Purchase Farms, Two Areas, Louisiana

Item	*Upland cotton area*		*Rice area*	
	Average cost	*Percentage of total cost*	*Average cost*	*Percentage of total cost*
	Dollars	*Percent*	*Dollars*	*Percent*
Farm, as purchased	1,893.35	49.5	6,320.09	69.2
Acquisition fees	21.32	0.6	26.25	0.3
Sub-total	1,914.67	50.1	6,346.34	69.5
Improvements added:				
Dwelling	1,237.19	32.4	1,790.70	19.6
Barn	357.02	9.3	400.00	4.4
Other buildings	87.00	2.3	156.23	1.7
Water supply	61.47	1.6	120.24	1.3
Fences	154.11	4.0	265.22	2.9
Land	10.54	0.3	48.27	0.6
Sub-total	1,907.33	49.9	2,780.66	30.5
Total	3,822.00	100.0	9,127.00	100.0
Cost:				
Per acre in farm	36.89	....	60.89	....
Per acre cropland	73.22	....	70.70	....

Adequate water supplies were provided on all the farms where they did not already exist. The costs of these varied widely in both areas; from $1.70 to $136 in the cotton area and from $7.50 to $514 in the rice area. The most elaborate and convenient systems were found in the latter area where the greatest costs were incurred.

Fencing was an item of cost on most of the units. The average amount spent on building fences in the cotton area was $154 and in the rice area

$265, while the range in individual amounts spent was from $20 to $300 and from $82 to $728 in the two areas, respectively (Table 4).

Land improvements were made on 15 of the upland cotton farms and on eight of those in the rice area. These improvements included terracing in the cotton area and the construction of protection levees, canals, and ditches in the rice area. In addition some orchards were established in both areas.

The average cost of the real estate including the improvements added after purchase was $3,822 in the cotton area and $9,127 in the rice area. The range in cost in the former area was from $2,597 to $5,077 and in the latter from $5,830 to $14,380. Approximately half of the total cost of the real estate in the cotton area was spent for the farm, as purchased, while the other half represented the cost of buildings and improvements added. In the rice area the initial cost of the farm was about 70 percent of the total outlay.

The average cost of the real estate per acre of land was $37 in the upland cotton area and $61 in the rice area. However, the average cost per acre of cropland was found to be greater in the cotton area, $73 as compared to $71 in the rice area.

Relation of Credit Used to Value of Farms

In acquiring ownership control of the tenant purchase farms, the new owners used credit freely. In the upland cotton area 98.1 percent of the total cost of the farms and the added improvements was paid with borrowed funds, and in the rice area, 93.8 percent of the cost was defrayed in this manner (Table 5). The average amount of credit used per farm in the two areas was $3,749 and $8,558, respectively. The average amount paid from the borrowers' resources was $73 in the cotton area and $569 in the rice area (Table 5).

In most cases, the total cost of the farm was paid with loan funds; however, one borrower in the upland cotton area paid $350 and three in the rice area paid $125, $600 and $800 respectively from their own resources. Since the time of purchase many of the farmers have made improvements which were not provided for in their loans. Twenty-four borrowers in the cotton area had spent amounts varying from $1.80 to $291 on improvements on their farms while in the rice area 27 of the borrowers had spent from $5.00 to $2,970 each. Most of the borrowers contributed some labor in the construction of the buildings and in the making of the other improvements. Twenty-nine of the operators in the cotton area reported an average of 45 days work spent in this manner while the 30 in the rice area reported an average of 46 days. The individual labor contributed varied from 6 to 200 days.

Total Investment in Real Estate and Operating Capital

The average investment per farm in real estate, livestock, machinery, and equipment in 1943 was $4,980 and $13,199 in the upland cotton and

TABLE 5. CREDIT USED BY 60 TENANT PURCHASE BORROWERS IN ACQUIRING FARMS, TWO AREAS, LOUISIANA, 1937-43

Item	Upland cotton: Amount	Upland cotton: Percentage of total cost	Rice: Amount	Rice: Percentage of total cost
	Dollars	*Percent*	*Dollars*	*Percent*
1. Cost of farms:				
a. Price paid at purchase	1,893.35	49.5	6,320.09	69.2
b. Acquisition fees	21.32	0.6	26.25	0.3
c. Added improvements	1,907.33	49.9	2,780.66	30.5
Total cost	3,822.00	100.0	9,127.00	100.0
2. Payment source:				
a. FSA land loan	3,749.00	98.1	8,558.00	93.8
b. Borrower's equity	73.00	1.9	569.00	6.2
Total	3,822.00	100.0	9,127.00	100.0

rice areas, respectively.[11] In the cotton area this investment ranged from $3,149 to $9,143 and in the rice area from $6,451 to $23,613.

The individual farm units in each area were ranked from high to low on the basis of the cost of real estate at purchase, plus the cost of permanent improvements added since purchase. The resulting averages of total capital investment for the upper, middle, and lower one-third of the farms grouped as stated above show considerable variation both within and between the areas (Table 6).

The average cost of the real estate in the three groups in the upland cotton area varied from 75.6 to 77.5 percent of the total farm capital investment, while in the rice area it varied from 65.2 to 74.2 percent. The value of livestock among the three groups varied from 17.2 to 19.8 percent of the total investment in the cotton area and from 11.3 to 17.8 percent in the rice area. The investment in machinery and equipment was about 5 percent of the total farm capital in the cotton area for all groups, while in the rice area, it ranged from 11.3 percent to 23.5 percent (Table 6).

The value of the real estate per acre for the three groups averaged $38, $35, and $39 in the cotton area and in the rice area $60, $54, and $76, respectively (Table 6). The highest value of real estate per acre was found in the lower group in each area. In both of these groups the average size farm was less than that in the other groups. In the cotton area the average size farm for the upper one-third group was 114 acres, for the middle group 112 acres, and for the lower group 84 acres, while

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[11] The data given in this section are based on 30 farms in each area which were owner-operated in 1943 and on which the major improvements had been completed.

TABLE 6. CAPITAL INVESTMENT IN REAL ESTATE, LIVESTOCK, MACHINERY AND EQUIPMENT, UPLAND COTTON AND RICE AREAS, LOUISIANA

Item	Unit	Average per farm in					
		Upland cotton area[3]			Rice area[3]		
		Upper one-third	Middle one-third	Lower one-third	Upper one-third	Middle one-third	Lower one-third
Real estate value[1]	Dollars	4,288.00	3,891.00	3,286.00	12,251.00	8,767.00	6,363.00
Livestock value[2]	Dollars	1,126.00	866.00	737.00	2,123.00	1,330.00	1,600.00
Machinery and equipment value	Dollars	261.00	264.00	223.00	4,430.00	1,720.00	1,013.00
Total items 1, 2 and 3	Dollars	5,675.00	5,021.00	4,246.00	18,804.00	11,817.00	8,976.00
Size of farm (average)	Acres	114.2	112.2	84.5	202.6	163.0	84.2
Real estate value:							
a. Per acre in farm	Dollars	37.55	34.68	38.89	60.47	53.79	75.57
b. Per acre in cropland (1943)	Dollars	75.10	69.48	75.37	66.44	66.32	89.87
Farm area in cropland	Percent	50.0	49.9	51.6	91.0	81.1	84.1
Percentage total value in:							
a. Real estate	Percent	75.6	77.5	77.4	65.2	74.2	70.9
b. Livestock	Percent	19.8	17.2	17.4	11.3	11.3	17.8
c. Machinery and equipment	Percent	4.6	5.3	5.2	23.5	14.5	11.3

[1] Value as of January 1, 1944. [2] Value taken as of January 1, 1944. [3] Farms are grouped according to real estate cost.

in the rice area the averages were 203, 163, and 84 acres, respectively. One reason for the great variation in size of farms in the latter area was that on six of them sugarcane was grown for sale to mills, and these units were smaller than the average rice farm and averaged 73.7 acres. Five of the six sugarcane farms came within the lower one-third group.

Data on total capital invested in farms purchased with FSA land loans are important because they give an approximate measure of the amount of capital investment required for operating family-size farms in the two areas. While there are differences of opinion as to what constitutes a family-size farm, the farms used in tabulating the data given in Table 6, were selected and approved for loans under the FSA ideal of such farms, and are probably more typical than any group which might be selected by other means. Because of the accepted federal policy of aiding veterans who are qualified and approved to acquire farms of family-size, information on the cost of farms largely purchased between 1938 and 1941 should be valuable in indicating the amount of capital needed to operate a family-size farm in the two areas. To the extent that it may be necessary to pay higher prices for land and the items necessary for operation, the data given above would be lower than the total capital which would be required to begin operating a farm in 1945.

Progress in Paying for Farms

An average of $850 had been paid on the real estate debts by the 1943 owner-operators in the upland cotton area, and $1,643 by those in the rice area (Table 7).[12] In the cotton area, 62.3 percent of the amount

TABLE 7. Sources of Income Used in Making Payments on 77 Tenant Purchase Debts, Two Areas, Louisiana

Source of income	*Average per farm*			
	37 borrowers, upland cotton area		*40 borrowers, rice area*	
	Dollars	*Percent*	*Dollars*	*Percent*
Earned income	529.34	62.3	1,395.81	84.9
Unearned income:				
Sale of timber	45.39	5.3	0.00	0.0
Sale of oil lease and royalty	138.65	16.3	102.70	6.3
Sale of other rights or properties	5.60	0.7	6.49	0.4
Total	189.64	22.3	109.19	6.7
Unused loan funds returned	130.77	15.4	138.12	8.4
Total paid	849.75	100.0	1,643.12	100.0
Percentage of maturities paid		168.5		152.3

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[12] All payments made to March 31, 1944, were included, as accounts do not become delinquent until that date although annual installments are due on December 31 of each year.

paid originated from income earned by the owner and his family, 22.3 percent from the sale of timber, oil leases, royalties, and other rights and properties, and 15.4 percent from unused loan funds. In the rice area 84.9 percent of the payments were made from earned income, 6.7 percent from the sale of oil leases, royalties, and other rights or properties, and 8.4 percent from unused loan funds (Table 7). Including payments from all sources, 168.5 percent of the amount due according to schedule to December 31, 1943 had been paid by the upland cotton borrowers and 152.3 percent by the farmers in the rice area.[13] A higher percentage of the maturities had been paid by the former group; however, a greater proportion was from unearned income than in the rice area.

In the upland area, six of the operators were current with their payments, 12 were ahead and 19 were behind schedule; while in the rice area 14 were current, 22 were ahead and only four were behind schedule (Table 8). Payments made from income received from the sale of oil leases, royalties, timber, rights of way, etc., and from unused loan funds are not used by the FSA in determining the schedule status of individual borrowers. When figured in this manner, the average percentage of maturities paid by the borrowers in the upland area was 105.0 and in the rice area 129.4.

TABLE 8. SCHEDULE STATUS OF TENANT PURCHASE BORROWERS WHO OPERATED FARMS AS OWNERS IN 1943, TWO AREAS, LOUISIANA

Item	37 *borrowers, upland cotton area*	40 *borrowers, rice area*
Number on schedule	6	14
Ahead of schedule:		
Number	12	22
Range of amounts	$ 8.08 - $1,774.73	$ 0.05 - $3,682.85
Behind schedule:		
Number	19	4
Range of amounts	$31.50 - $706.30	$24.29 - $ 265.83
Average due to Dec. 31, 1943	$504.37	$1,078.29
Average paid to March 31, 1944 (excluding extra payments)	$529.34	$1,395.81
Percentage of maturities paid (excluding extra payments)	105.0	129.4

Two borrowers, one in each area, had paid their entire land purchase obligations as of March 31, 1944. The owner in the cotton area paid his loan after five years of operation, but 48 percent of the original debt of $4,350 was paid with the proceeds from the sale of an oil lease in 1943. In addition, he had sold most of his livestock and worked in a war plant during several months of the last year.

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[13] "According to schedule" refers to the amount that would have been due on a fixed payment basis at 4.326 percent of the loan annually.

The debt-free owner in the rice area paid his obligations after only two years of operation under the program. His initial loan of $6,530 was reduced by $2,550 when he returned the funds that had been set up for buildings. Wartime regulations had prohibited the planned construction. The balance of the real estate debt was retired from farm income as the operator was fortunate in making large rice crops in 1942 and in 1943 and in receiving wartime prices for them. His farm income was not entirely from the tenant purchase farm, as he rented 77 acres of land in addition on which rice was planted in 1943.

Although 19 of the borrowers in the cotton area were behind schedule, only a few of them presented any serious problems. Three of these had moved from their farms after a completion of the 1943 crop year, but it was thought that these units could be transferred to other eligible families without any loss to the government. There is a probability that one or two other borrowers may give up their farms sometime in the future as judged by their indifference toward paying their real estate debts. Most of the operators who had not paid up to schedule, however, were behind for valid reasons. Some of them had suffered from poor crops due to unfavorable weather conditions for one or more years, and others were developing livestock programs which had not begun to give cash returns. In one case, the operator had been injured in an accident while working away from home and had been unable to work for several months. It was anticipated that these families would be able to catch up with their payments in a few years. The four borrowers who were behind schedule in the rice area presented no serious problems and it was expected that their payments would be on schedule in the near future.

In addition to those who were operating their farms as owners in 1943 and were behind schedule, the three borrowers in the cotton area who had left their farms previous to the 1943 crop season were also behind with their payments an average of $354.[14] FSA officials were confident that at least one of the farms involved could be transferred to a new owner without any loss to the government, and that in any case the total sum which might be lost would be small.

From the varying dates of purchase to March 31, 1944, an average of $814 had been paid on the tenant purchase debts by the 40 borrowers in the cotton area, listed as owners on December 31, 1943 and $1,643 by those in the rice area. Of these amounts, averages of $516 and $918 had been applied to the principal debts respectively (Table 9). The average amount due according to schedule for this group in the cotton area was $514 and in the rice area $1,078.

Gain in Net Worth

Since the operation of a farm involves both operating capital and capital invested in real estate, the gain in net worth on all operations is a better measure of financial progress than is the reduction in real estate debt. This is especially true for young farmers, who are generally in the stage where operating capital is being increased.

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[14] The three borrowers who had abandoned their farms, but were still listed as owners on December 31, 1943.

Borrowers who had been operating their farms as owners for five years had increased their net worth an average of $1,894 in the upland cotton area and $8,659 in the rice area (Table 10). The four year owners had increased their net worth by $1,751 and $5,993, respectively; the three year owners by $1,543 and $6,279; and the two year owners by $1,465 and $3,561 (Table 10). Average assets, liabilities, and net worth for the four groups of borrowers at the time their loans were approved and as of January 1, 1944 are given in Appendix Tables 2, 3, 4, and 5.

TABLE 9. Amounts Due and Paid on Tenant Purchase Loans, Two Areas, Louisiana, 1937 - March 31, 1944

Item	*Average per farm*[1]	
	Upland cotton area	*Rice area*
	Dollars	*Dollars*
Total loan	3,743.61	7,977.82
Payments made:		
Principal	516.12	918.44
Interest	297.39	724.68
Total	813.51	1,643.12
Principal unpaid	3,227.49	7,059.38
Amount due according to schedule to Dec. 31, 1943	514.30	1,078.29

[1] The average loan per farm shown in this table includes data for all units that had been operated under the program prior to January 1, 1944. The amount shown in Table 5 included the loans of 30 farmers in each area who had completed the major improvements on their farms and operated them in 1943.

TABLE 10. Gain in Net Assets of Tenant Purchase Borrowers Since Acquiring Farms, Two Areas, Louisiana

Length of operation as owners	*Number farms included*	*Average gain in assets per farm*	*Average gain in assets per year*
Years	*Number*	*Dollars*	*Dollars*
Upland cotton area:			
Two	11	1,465.38	732.69
Three	13	1,542.86	514.29
Four	6	1,751.18	437.80
Five	5	1,893.55	378.71
Rice area:			
Two	17	3,561.49	1,780.75
Three	8	6,279.26	2,093.09
Four	4	5,992.82	1,498.20
Five	8	8,658.55	1,731.71

The data on gains in net worth, show that the new owners have made substantial financial progress during the relatively short period the FSA land program has been in operation. It should be recognized that they have had the advantage of a higher price level for farm products during the war than was anticipated at the time most of the farms were purchased. Without the benefits of wartime prices, the increase in net worth would have been less, but still sufficiently large to be encouraging.

CHARACTERISTICS OF TENANT PURCHASE FAMILIES

All of the 77 families who were operating tenant purchase units as owners in the two areas in 1943, were "normal" families at the time their loans were approved; that is, they were made up of husband and wife or husband, wife, and children (Table 11). All except three families had children, one of these being in the upland cotton area and two in the rice area. In the North Louisiana area 62.2 percent of the families consisted of husband, wife, and children sixteen years old or less, while in the South Louisiana area 85.0 percent of the families were in this class. The percentage of families with children in all age groups was greater in the cotton area than in the rice area, being 32.4 and 10.0 percent, respectively (Table 11).

TABLE 11. DISTRIBUTION OF TENANT PURCHASE FAMILIES, ACCORDING TO TYPE OF FAMILY, TWO AREAS, LOUISIANA, AT TIME OF LOAN APPROVAL AND IN 1943[1]

Type of family	*At approval*		1943		*At approval*		1943	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
Normal families:								
Husband and wife	1	2.7	3	8.1	2	5.0	1	2.5
Husband, wife, children 16 yrs. or under only	23	62.2	19	51.4	34	85.0	26	65.0
Husband, wife, children under 16 yrs., 16 yrs. and over	12	32.4	13	35.1	4	10.0	11	27.5
Husband, wife, children under 16 yrs. only	1	2.7	1	2.7	0	0.0	2	5.0
Broken families	0	0.0	1	2.7	0	0.0	0	0.0
Total	37	100.0	37	100.0	40	100.0	40	100.0

[1] Data included only for those operating farms as owners in 1943.

The average number of children living at the time of loan approval for the 37 families in the cotton area was 3.4, while the average number in the rice area was 2.8. The number of children per family varied from none to nine and from none to seven in the two areas, respectively. The number of children per Negro family was greater than the number per white family in both areas (Table 12).

TABLE 12. AVERAGE NUMBER CHILDREN LIVING AT HOME IN TENANT PURCHASE FAMILIES, TWO AREAS, LOUISIANA, AT TIME OF LOAN APPROVAL AND IN DECEMBER, 1943

Race of families	*Average number children*			
	Upland cotton area		*Rice area*	
	At loan approval	*December* 1943	*At loan approval*	*December* 1943
White	3.0	3.6	2.7	3.1
Negro	4.4	5.1	3.5	4.5
All	3.4	4.0	2.8	3.2

The composition of the families had not changed greatly from the time of loan approval until 1943. One family had been broken by the death of the mother, and in two cases all of the children had left home. However, the average number of children living at home per family had increased in each color group in each area (Table 12).

The age of the family head is an important factor in making selections for farm ownership loans, as the loans are amortized over a period of forty years. Young operators have a better chance to retire the mortgage debt before the period of old age. The average age of the borrowers at the time of loan approval in the cotton area was 38.1 years and in the rice area 34.4 years. The ages varied from 27 to 54 years and from 23 to 48 in the two areas, respectively. Only 8.1 percent of the operators in the upland area were under 30 at the time of their loan approval while 25.0 percent of those in the rice area were in this age group (Table 13). Forty-six percent were forty and over in the former area as com-

TABLE 13. AGES OF FARMERS OBTAINING TENANT PURCHASE LOANS, TWO AREAS, LOUISIANA[1]

Age of operators time of loan approval	*Distribution of borrowers*			
	Upland cotton area		*Rice area*	
Years	*Number*	*Percent*	*Number*	*Percent*
Under 24	0	0.0	2	5.0
25-29	3	8.1	8	20.0
30-34	10	27.0	10	25.0
35-39	7	18.9	12	30.0
40-44	9	24.4	7	17.5
45-49	6	16.2	1	2.5
50-or over	2	5.4	0	0.0
Total	37	100.0	40	100.0

[1] Includes only those operating farms as owners in 1943.

pared to only 20.0 percent in the latter area. The average age of the wives was less than that of the operators by about four years in the cotton area and two years in the rice area.

The operators in the upland cotton area had 6.5 years of formal education and those in the rice area 5.3 years. In both areas the negro borrowers had attended school fewer years than the white operators (Table 14). One farmer in the cotton area and four in the rice area reported that they had not completed as much as one year of school, while 16.2 and 52.5 percent in the two areas, respectively, reported four years or less schooling (Table 15). About 25 percent of the operators in each area completed 8 to 10 years of formal education and 5.4 and 12.5 percent, respectively, completed high school (Table 15). None of the negro operators in the cotton area had gone beyond the seventh grade, and in the rice area beyond the fourth grade (Appendix Table 6).

TABLE 14. AVERAGE YEARS OF SCHOOL ATTENDANCE OF TENANT PURCHASE OPERATORS, TWO AREAS, LOUISIANA

Area	*Average years of schooling received*		
	White	*Negro*	*All*
Upland cotton	7.2	4.5	6.5
Rice	5.4	2.0	5.3

TABLE 15. DISTRIBUTION OF TENANT PURCHASE OPERATORS ACCORDING TO YEARS OF SCHOOLING RECEIVED, TWO AREAS, LOUISIANA[1]

School years completed	*Upland cotton area*		*Rice area*	
	Number	*Percent*	*Number*	*Percent*
None	1	2.7	4	10.0
1-4	5	13.5	17	42.5
5-7	20	54.1	4	10.0
8-10	9	24.3	10	25.0
11	2	5.4	5	12.5
Total	37	100.0	40	100.0

[1] Those operating farms as owners in 1943.

Ninety-five percent of the borrowers in the cotton area and 98 percent in the rice area were born on farms. Most of the operators' wives were also born on farms, but the percentage was not as high as that for the operators. Seventy-two percent of the borrowers in the cotton area and 64 percent in the rice area had grown up on farms owned by their parents (Appendix Table 7). Fifty-four percent of the borrowers in the cotton area were born in the parish in which they purchased a farm, and an additional 19 percent in an adjoining parish, while the remaining 27 percent were born outside the state. In the rice area, 82 percent of the operators were born in the parish in which they purchased a farm, an additional 10 percent in adjoining parishes, and only 3 percent outside the state.

The borrowers in the cotton area had 24 years of farming experience from the age of 12 until their approval for tenant purchase loans, and those in the rice area had 21 years. The years of farming experience of individuals ranged from 12 to 37 and from 8 to 35 in the two areas, respectively. Thirty-six out of 37 upland cotton borrowers reported experience on farms as a part of their families, and in addition, one of them reported experience as a part owner, one as a hired man, one as a sharecropper, six as tenants and one as both a tenant and a sharecropper on the home farm. Thirty-nine of the 40 borrowers in the rice area had worked as a part of their families; also, one had experience as a sharecropper, one as both a sharecropper and tenant, two as both hired men and tenants, and nine as tenants on the home farms.

Varying amounts of experience were reported on other farms. Ninety-five percent of the operators in the cotton area had had experience on farms other than their home farms. Of this group, 2.8 percent had worked as both tenant and owner, 8.6 percent as hired men, sharecroppers and tenants, 8.6 percent as sharecroppers, tenants and owners, 28.6 as tenants only, and 51.4 as both sharecroppers and tenants. Ninety-five percent of the operators in the rice area had also had experience on farms other than their home farms prior to the time of attaining their present status. Of these, only one, 2.6 percent, had been an owner, and he had experience as a sharecropper and tenant also; 5.3 percent had been sharecroppers, 5.3 percent hired men, sharecroppers and tenants, 5.3 percent hired men and tenants, 13.2 percent sharecroppers and tenants and 68.3 percent tenants, only.

All land purchase borrowers in both the cotton and rice areas were engaged in farming at the time they applied for loans. Sixty-eight percent in the former area and 75 percent in the latter indicated that they had farmed throughout their lives. Most of the borrowers who had worked in occupations other than farming had done so for only a few years; however, one Negro in Jackson Parish reported 17 years and one white operator in Vermilion Parish reported ten years of non-farm employment.

The 12 operators in the cotton area who reported non-farm experience had spent an average of 3.9 years in one or more of 12 different occupations while ten operators in the rice area reported an average of 2.8 years in one or more of seven different occupations other than farming. Four of the North Louisiana borrowers had worked in oil fields, three in sawmills, two in stores, two in forests as timber cutters and one each in the following occupations: highway construction and maintenance, mechanics, the U. S. Army, railroad work, mining, welding, tire repair work and soil conservation. The non-farm experience of the operators in the rice area was less varied. Three of them had worked in oil fields, two on highways, two as policemen, two as mechanics and one each in the following: sawmills, U. S. Navy and mines.

The data indicate that families who received farm ownership loans in the cotton area had been less stable in their residence previous to obtaining them than those families in the rice area. The cotton farmers had lived on more farms and their average length of residence on each was less. The average number of farms lived on after leaving the home farm by the North Louisiana operators was 4.6 as compared to 2.6 for the South Louisiana borrowers. The average length of residence on each farm was three years for the former group and five years for the latter.

A study of the location of the tenant purchase farm in relation to the farm on which the family lived the year previous to becoming an owner shows that 16 percent of the operators in the cotton area and 28 percent in the rice area purchased the farms on which they were living as tenants at the time their loan applications were approved. The length of residence on these farms varied from one to 50 years and one operator purchased the farm on which he had lived his entire life.

For those borrowers who did not buy the farms on which they were living, the average distance of the farm purchased from the farm lived on the year previous to becoming an owner was 11.2 miles in the cotton area and 7.3 miles in the rice area. The distances moved by individuals varied from less than one mile in each area to 28 miles in the cotton area and 45 miles in the rice area. These data show that tenants did not move far enough in either area to be unfamiliar with the types of enterprises suited to the farms they purchased with the aid of tenant purchase loans.

From interviews with the borrowers, the impression was gained that tenant purchase farmers in the rice area have a greater determination to retire their mortgage debt than do those in the cotton area. Because of higher earnings, it will be less difficult for the rice farmers to retire their debts and at the same time maintain a comfortable level of living. In the cotton area several operators felt that too much had been paid for the land, while in the rice area all were satisfied. None of the operators in the rice area felt that the buildings constructed on their units had been too expensive, while three of them stated that they would have preferred better quality and larger houses. As contrasted with the attitude in the rice area, several of the borrowers in the cotton area felt that the buildings were too expensive and should have been constructed at a smaller cost. A few of the cotton borrowers displayed an inclination to get as much as possible from the government without trying to make repayment.

That the borrowers in the rice area had a greater determination to become debt-free owners was evidenced by the fact that none of them had abandoned their units, while in the cotton area eight of the original borrowers had given up their farms. Five of these operators were white and three were colored. In five cases families had been selected to replace the borrowers who abandoned their farms, but of these second owners two had left the farms and only one had been replaced, so that four of the units were being rented in February, 1944. It was found that two of the first borrowers did not move to the farms which they bought with tenant purchase loans. One decided that he didn't want to move to the new community and the other found a smaller place with cheaper buildings where he thought it would be easier to pay his debt. Four of the families who had given up their farms were reported to have had poor attitudes toward cooperating with Farm Security supervisors and as having made little effort to pay their financial obligations. Two of the borrowers who had left their farms said that they had operated the units for a short time but found that they could not "make a living" and retire the indebtedness. They may have been correct in their analysis as FSA officials later decided the two farms were uneconomic units and should be combined into one.

Another family, a colored preacher, had become dissatisfiied and moved. His sons had been drafted for service in the Army and he had no desire to operate the farm with his own labor. The remaining borrower who abandoned his farm, stated his unit was too large for him to operate successfully and that he wanted a place he could pay for more easily. Undoubtedly there were other reasons involved than the ones stated above, as poor management and indifference were in evidence in at least three of the cases.

The human element is always an important factor and much time and effort is spent in careful investigation of applicants. However, behavior is not always predicable and a few cases of error are to be expected. Different people will deal with given conditions of soils, management, rotations, and debts in a diverse manner and with widely varying results. Thus a combination of favorable fundamental conditions may exist, but poor management and indifference may be the major contributing factors to failure.

SUMMARY AND CONCLUSIONS

1. The average size of tenant purchase farm units in the upland cotton area and the rice area exceeded the average size of farms in the same areas reported in the 1940 Census. In the cotton area, they were 15 acres larger while in the rice area they were 51 acres larger than the census average. This reflects the policy under the program to purchase enough land to provide economic units, capable of supporting a reasonable standard of living and of retiring the mortgage debts in 40 years or less.

2. In the cotton area the average cost of the real estate was $3,822,

of which approximately 50 percent was for the farm as purchased, and 50 percent for the improvements added after purchase. In the rice area the average cost of the real estate was $9,127 of which 70 percent was for the farm as purchased, and 30 percent for the improvements added.

3. The average cost of farms in the rice area was three times the cost of those in the cotton area, and the buildings and improvements added were about 50 percent more costly.

4. The average cost of the real estate per acre in the rice area was over 1.5 times as great as that in the cotton area; however, the cost per acre of cropland was slightly higher in the cotton area as a smaller percentage of the total farm acreage was in cultivation.

5. Credit was used freely by the tenant purchase borrowers in establishing themselves as farm owners. In the cotton area 98.1 percent of the total cost of the farms was paid for with borrowed funds, while 93.8 percent of the total cost in the rice area was paid with loan funds.

6. The average investment in real estate, livestock, machinery and equipment on farms in the rice area where the major improvements had been completed was about 3 times as great as in the cotton area. The cost of the real estate in the rice area represented 69 percent of the total capital invested in the farm business; livestock accounted for 13 percent; and machinery and equipment for 18 percent of the total investment. In the upland cotton area, the cost of the real estate was 77 percent, livestock 18 percent, and machinery and equipment 5 percent of the total capital investment. A greater proportion of the farm capital in the rice area was invested in machinery and equipment than in the cotton area and this reflects differences in the degree of mechanization. Rice planting and harvesting are largely mechanized and costly equipment is commonly used.

7. When payments made from all sources of income are included, the 1943 operators in the cotton area had paid 168 percent of the amount due according to schedule to December 31, 1943, and in the rice area 152 percent. In the cotton area, six farmers were on schedule with their payments, 12 were ahead, and 19 were behind, while in the rice area 14 were on schedule, 22 were ahead, and only four were behind. With few exceptions, those who had not paid up to schedule had valid reasons, and were expected to become current within a reasonable period.

8. The borrowers in the upland cotton area who had been operating their tenant purchase farms as owners for five years had made an average gain in net assets of $379 per year, those operating for four years had made an average gain of $438 per year, those operating for three years, $514, and those operating for two years, $733. The five-year owners in the rice area had gained $1,732 per year, the four-year owners, $1,498, the three-year owners, $2,093, and the two-year owners $1,781. The higher average financial gains per year in the rice area are not associated with expenditures for family living being lower than in the cotton area. They

are associated with larger crop areas per family, more efficient production through mechanization, a lower investment in buildings in relation to the total investment in real estate, and a larger amount of capital per family invested in productive land, livestock, and equipment.

9. As a whole, the tenants purchasing farms by means of FSA loans prior to 1943 had progressed on the road to debt free farm ownership and most of them should be able to complete the payments on their farms in due time. After the lapse of another decade which will include the post-war period, comparisons of net worth may be made which will be more valuable as a measure of the progress made by tenant purchase families in the two areas, because at present the time that has elapsed since purchase is short and includes only a period of rising prices for farm products.

10. At the time of loan approval the average age of the borrowers in the cotton area was 38.1 years, and 34.4 years in the rice area.

11. The operators in the cotton area had attended school slightly more years than had those in the rice area. None of the operators appeared to be severely handicapped because of inadequate education.

12. In general the families have a higher standard of living than they did as tenants, especially since they have better houses and more conveniences. They are more substantial citizens since they have a greater opportunity to participate in programs dealing with schools, churches, and cooperative organizations. As a whole it appears that the tenant purchase loan program is making a contribution toward a more permanent and satisfactory agriculture in the State of Louisiana.

APPENDIX TABLES

TABLE 1. Farms Bought With Tenant Purchase Loans, Selected Parishes, Upland Cotton and Rice Areas, Louisiana, 1937 - May 1, 1944

Area and parish	*Number farms bought by*		
	White	*Negro*	*Both*
Upland cotton area:			
Bienville	5	2	7
Claiborne	7	1	8
Jackson	3	0	3
Lincoln	10	7	17
Union	4	1	5
Total	29	11	40
Rice area:			
Acadia	28	1	29
Vermilion	16	1	17
Total	44	2	46

TABLE 2. Assets, Liabilities, and Net Worth of Tenant Purchase Borrowers, Two Areas, Louisiana, at Time of Loan Approval and on January 1, 1944

Five-year owners

Item	*Average per borrower*			
	Upland cotton area (5 borrowers)		*Rice area (8 borrowers)*	
	At loan approval	*Jan. 1, 1944*	*At loan approval*	*Jan. 1, 1944*
	Dollars	*Dollars*	*Dollars*	*Dollars*
Assets:				
Real estate	0.00	4,019.64	0.00	9,422.55
Machinery and equipment[1]	164.70	317.08	1,044.50	3,196.94
Feed, seed, and supplies	141.40	283.20	477.38	888.88
Livestock	428.70	766.60	922.26	1,532.00
Cash on hand	30.00	110.60	141.88	1,476.88
Automobile	0.00	0.00	425.00	550.00
Household goods	235.60	699.64	430.61	1,435.16
Other property	173.60	75.55	308.12	1,269.71
Total	1,174.00	6,272.31	3,749.75	19,772.12
Liabilities:				
Real estate	0.00	3,377.16	0.00	7,506.90
FSA standard loan	57.40	0.00	30.12	157.04
Other debts	115.00	0.00	270.00	0.00
Total	172.40	3,377.16	300.12	7,663.94
Net worth	1,001.60	2,895.15	3,449.63	12,108.18

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[1] Includes value of trucks and tractors.

TABLE 3. Assets, Liabilities, and Net Worth of Tenant Purchase Borrowers, Two Areas, Louisiana, at Time of Loan Approval and on January 1, 1944
Four-year owners

Item	*Average per borrower*			
	Upland cotton area (6 borrowers)		*Rice area (4 borrowers)*	
	At loan approval	*Jan. 1, 1944*	*At loan approval*	*Jan. 1, 1944*
	Dollars	*Dollars*	*Dollars*	*Dollars*
Assets:				
Real estate	0.00	3,597.59	0.00	11,290.16
Machinery and equipment[1]	62.33	237.44	1,896.25	3,149.50
Feed, seed, and supplies	173.42	296.08	666.75	721.75
Livestock	418.00	815.83	1,525.00	3,052.25
Cash on hand	9.50	51.94	692.00	319.75
Automobile	33.33	233.33	75.00	425.00
Household goods	270.52	774.38	529.52	1,211.87
Other property	135.40	152.70	140.00	35.00
Total	1,102.50	6,159.29	5,524.52	20,205.28
Liabilities:				
Real estate	0.00	3,200.45	0.00	9,738.79
FSA standard loan	118.84	233.83	0.00	189.65
Other debts	14.33	4.50	1,240.50	0.00
Total	133.17	3,438.78	1,240.50	9,928.44
Net worth	969.33	2,720.51	4,284.02	10,276.84

[1] Includes value of trucks and tractors.

TABLE 4. Assets, Liabilities, and Net Worth of Tenant Purchase Borrowers, Two Areas, Louisiana, at Time of Loan Approval and on January 1, 1944
Three-year owners

Item	*Average per borrower*			
	Upland cotton area (13 borrowers)		*Rice area (8 borrowers)*	
	At loan approval	*Jan. 1, 1944*	*At loan approval*	*Jan. 1, 1944*
	Dollars	*Dollars*	*Dollars*	*Dollars*
Assets:				
Real estate	0.00	3,954.08	87.00	9,980.19
Machinery and equipment[1]	58.58	221.67	1,684.63	2,394.37
Feed, seed, and supplies	140.06	328.29	276.50	512.13
Livestock	400.99	988.77	555.37	1,383.03
Cash on hand	3.46	65.65	83.16	1,587.45
Automobile	65.39	81.54	268.75	387.50
Household goods	214.19	564.04	260.23	1,163.29
Other property	112.85	37.38	440.38	244.75
Total	995.52	6,241.42	3,656.02	17,652.71
Liabilities:				
Real estate	0.00	3,444.30	0.00	8,353.68
FSA standard loan	141.07	437.01	0.00	20.38
Other debts	39.12	1.92	677.25	20.62
Total	180.19	3,883.23	677.25	8,394.68
Net worth	815.33	2,358.19	2,978.77	9,258.03

[1] Includes value of trucks and tractors.

TABLE 5. ASSETS, LIABILITIES, AND NET WORTH OF TENANT PURCHASE BORROWERS, TWO AREAS, LOUISIANA, AT TIME OF LOAN APPROVAL AND ON JANUARY 1, 1944

Two-year owners

Item	*Average per borrower*			
	Upland cotton area (11 *borrowers*)		*Rice area* (17 *borrowers*)	
	At loan approval	*Jan. 1, 1944*	*At loan approval*	*Jan. 1, 1944*
	Dollars	*Dollars*	*Dollars*	*Dollars*
Assets:				
Real estate	22.73	3,556.31	93.23	7,141.16
Machinery and equipment[1]	61.14	215.91	814.18	1,420.47
Feed, seed, and supplies	120.18	279.18	205.94	496.74
Livestock	416.82	788.73	612.89	1,351.48
Cash on hand	22.27	80.64	169.63	559.77
Automobile	72.73	95.45	104.41	202.94
Household goods	225.60	643.73	297.63	1,101.08
Other property	17.36	44.68	142.13	155.73
Total	958.83	5,704.63	2,440.04	12,429.37
Liabilities:				
Real estate	0.00	3,217.69	0.00	6,539.65
FSA standard loan	156.91	285.55	72.67	160.22
Other debts	78.18	12.27	200.60	1.24
Total	235.09	3,515.51	273.27	6,701.11
Net worth	723.74	2,189.12	2,166.77	5,728.26

[1] Includes value of trucks and tractors.

TABLE 6. DISTRIBUTION OF TENANT PURCHASE OPERATORS ACCORDING TO YEARS OF FORMAL EDUCATION RECEIVED, TWO AREAS, LOUISIANA

School years Completed	*Upland cotton area*				*Rice area*			
	White		*Negro*		*White*		*Negro*	
	No.	*Percent*	*No.*	*Percent*	*No.*	*Percent*	*No.*	*Percent*
None	0	0.0	1	10.0	4	10.5	0	0.0
1-4	2	7.4	3	30.0	15	39.5	2	100.0
5-7	14	51.9	6	60.0	4	10.5	0	0.0
8-10	9	33.3	0	0.0	10	26.4	0	0.0
11 years	2	7.4	0	0.0	5	13.1	0	0.0
Total	27	100.0	10	100.0	38	100.0	2	100.0

TABLE 7. TENURE STATUS OF THOSE PARENTS OF FARM OWNERSHIP BORROWERS WHO WERE FARMERS, TWO AREAS, LOUISIANA[1]

Area and status	*Distribution of parents of borrowers*					
	White		*Negro*		*Total*	
	Number	*Percent*	*Number*	*Percent*	*Number*	*Percent*
Upland cotton:						
Owner	23	88.5	3	30.0	26	72.2
Tenant	2	7.7	6	60.0	8	22.2
Sharecropper	1	3.8	1	10.0	2	5.6
Total	26	100.0	10	100.0	36	100.0
Rice:						
Owner	24	64.9	1	50.0	25	64.1
Tenant	13	35.1	1	50.0	14	35.9
Sharecropper	0	0.0	0	0.0	0	0.0
Total	37	100.0	2	100.0	39	100.0

[1] Status of parents taken at the time of marriage of borrowers.

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AN ECONOMIC STUDY OF PEACH PRODUCTION IN LOUISIANA

By

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SUMMARY 30

AN ECONOMIC STUDY OF PEACH PRODUCTION IN LOUISIANA

In recent years considerable interest has arisen throughout the northern part of Louisiana in the development of peach production on a commercial scale. The production of peaches is not new to many farmers in the sandy hill areas of Louisiana, but the enterprise is one that has not been developed to any large extent. The decline of the cotton enterprise which began in 1933 has focused attention on possible alternative crops which may be profitably produced—thus taking up the "slack" in farming systems by providing fuller utilization of the farm resources, land, labor, and management.

In order to make a proper evaluation of peach production and the further possibilities of expanding the enterprise, a study has been made of a group of commercial orchards. The purposes of this study are as follows: (1) to determine the cost of establishing commercial peach orchards; (2) to determine the costs and returns from the enterprise; (3) to make some observations on the enterprise as it is being handled under Louisiana conditions; (4) to determine whether or not it would be economically desirable to expand the commercial production of peaches in Louisiana.

TABLE 1. THE NUMBER OF PEACH TREES IN LOUISIANA BY TYPE OF FARMING AREAS, 1940.[1]

Type of Farming Area	*Number of Trees*					
	Bearing age		*Less than bearing age*		*Total*	
	number	*percent*	*number*	*percent*	*number*	*percent*
North Louisiana Upland Cotton Area	141,086	34.9	85,066	32.3	226,152	33.8
Central Louisiana Cut-over Pine Area	32,663	8.1	20,711	7.9	53,374	8.0
Red River Delta Area	71,558	17.7	47,049	17.8	118,607	17.7
Cut-over Flatwoods Area	33,877	8.4	17,430	6.6	51,307	7.7
Louisiana Rice Area	23,421	5.8	14,519	5.5	37,940	5.7
Brown Loam Mixed Farming Area	2,390	.6	2,105	.8	4,495	.7
Mississippi River Delta Cotton Area	51,338	12.7	44,084	16.7	95,422	14.3
Central Louisiana Mixed Farming Area	28,778	7.1	13,957	5.3	42,735	6.4
Sugarcane Area	8,207	2.0	6,496	2.5	14,703	2.2
East Louisiana Cotton, Dairy, and Strawberry Area	10,319	2.5	11,549	4.4	21,868	3.3
New Orleans Dairy, Truck, and Fruit Area	1,045	.2	616	.2	1,661	.2
TOTAL, ALL AREAS	404,682	100.0	263,582	100.0	668,264	100.0

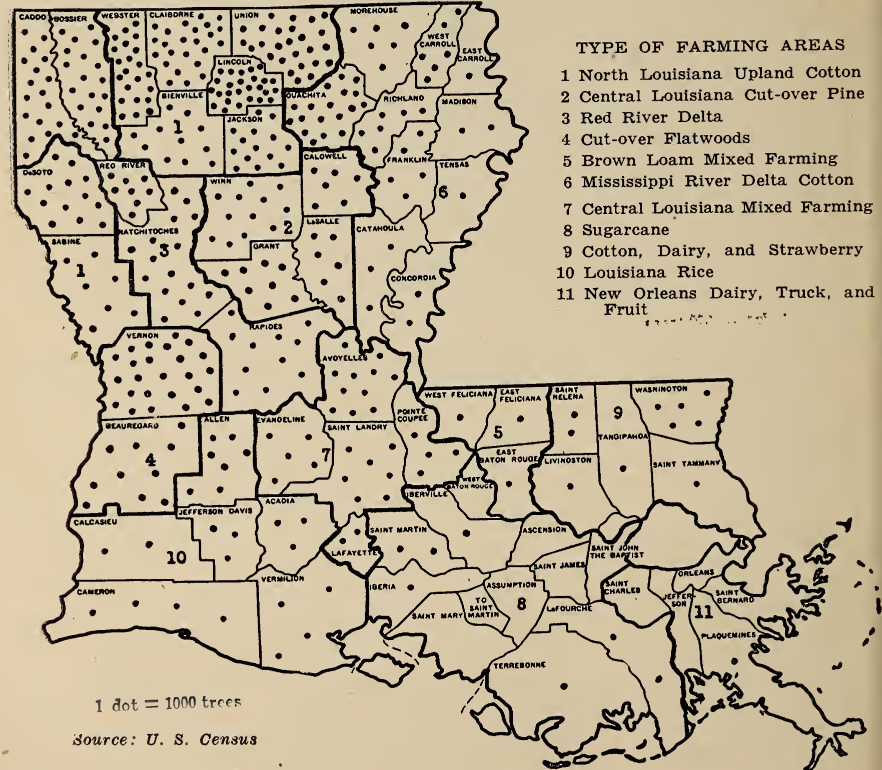
[1] United States Census, 1940.

THE EXTENT OF PEACH PRODUCTION IN LOUISIANA

Peaches are grown in every area of the state, but about one-third of all trees are found in the North Louisiana Upland Cotton Area. This area is surrounded by the Mississippi Delta Cotton Area on the East, the Red River Delta Area on the West, and the Central Louisiana Cut-Over Pine Area on the South. Approximately 40 percent of the trees in Louisiana are found in the three adjacent areas. Thus, nearly three-fourths of all peach trees are located in Northern Louisiana, table 1.

The distribution of peach trees of bearing age in Louisiana is shown in figure 1. The distribution of peach trees of less than bearing age shown in figure 2 follows a very similar pattern, and indicates that little change is taking place in the general location of peach production in Louisiana.

THE NUMBER OF PEACH TREES IN LOUISIANA
OF BEARING AGE IN 1940



TYPE OF FARMING AREAS

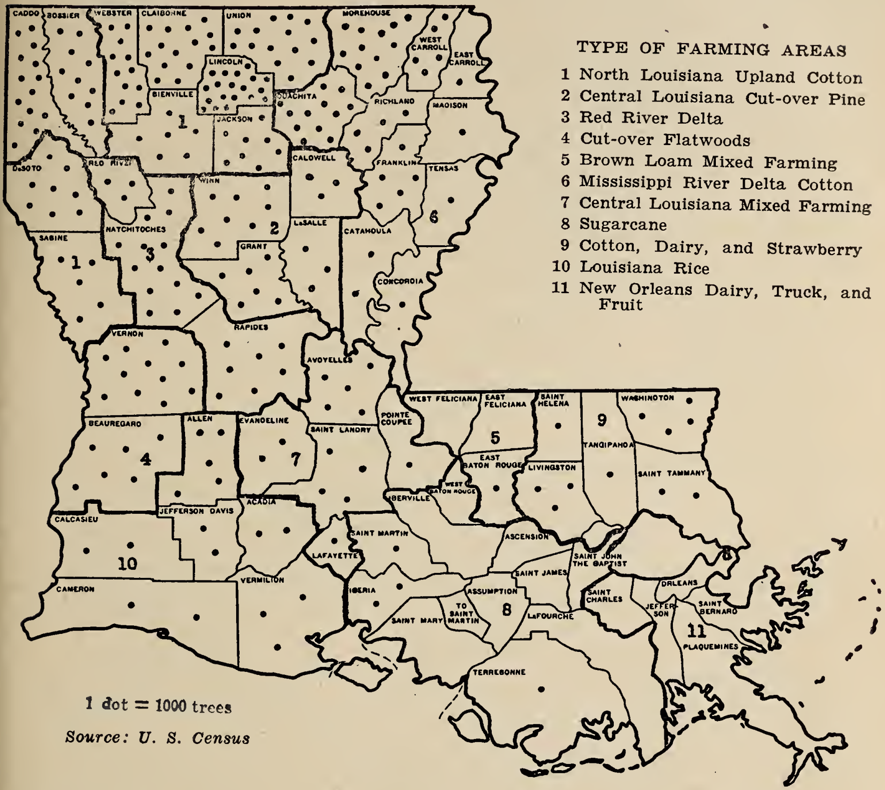
1 North Louisiana Upland Cotton
2 Central Louisiana Cut-over Pine
3 Red River Delta
4 Cut-over Flatwoods
5 Brown Loam Mixed Farming
6 Mississippi River Delta Cotton
7 Central Louisiana Mixed Farming
8 Sugarcane
9 Cotton, Dairy, and Strawberry
10 Louisiana Rice
11 New Orleans Dairy, Truck, and Fruit

1 dot = 1000 trees

Source: U. S. Census

FIGURE 1.—Most of the trees of bearing age are found in the North Louisiana Upland Cotton Area and adjacent areas. The number of trees is small in the southern areas of the state.

THE NUMBER OF PEACH TREES IN LOUISIANA LESS THAN BEARING AGE IN 1940

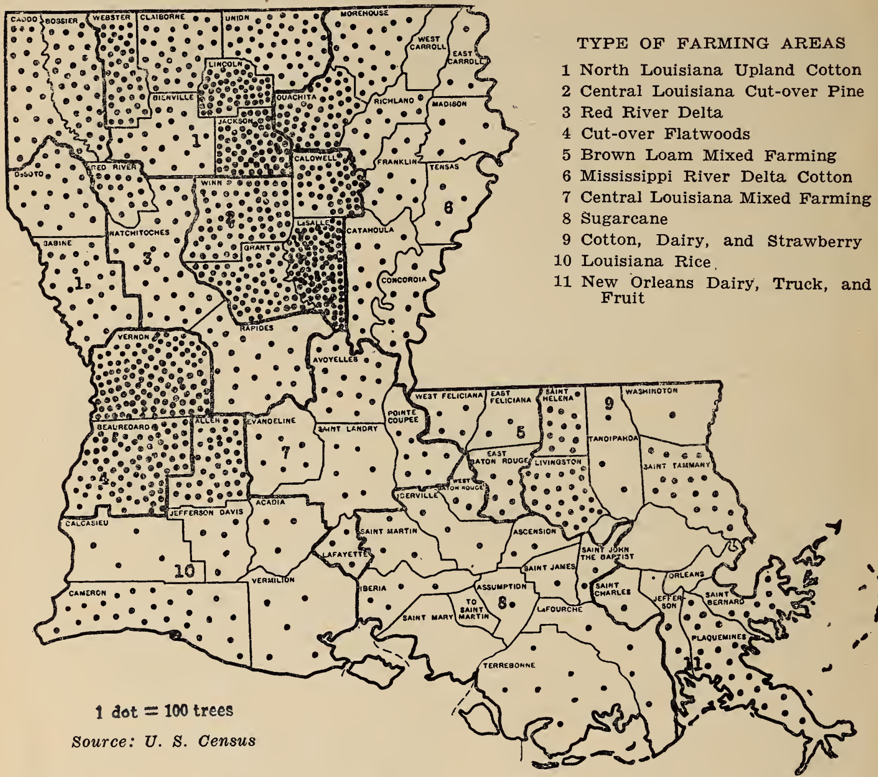


Source: U. S. Census

FIGURE 2.—The distribution of trees less than bearing age follows a pattern similar to that of bearing trees, and indicates that no significant shifts in production areas are taking place.

The greatest concentration of peach trees, however, is not found in the North Louisiana Upland Cotton Area, but in the Central Louisiana Cut-over Pine Area and the Cut-over Flatwoods Area. The density of peach trees per 10,000 acres of cropland harvested is shown in figure 3. There is considerably greater concentration of trees in Lincoln and Jackson parishes than in any other section of the North Louisiana Upland Cotton Area. The density is greatest in the Central Louisiana Cut-over Pine Area, and the Cut-over Flatwoods Area because the acreage of cultivated cropland is small in these areas and not because of exceedingly large numbers of trees.

THE NUMBER OF PEACH TREES IN LOUISIANA PER 10,000 ACRES OF CROPLAND HARVESTED



1 dot = 100 trees

Source: U. S. Census

FIGURE 3.—The greatest concentration of peach trees in relation to the harvested cropland is found in North Central and West Central Louisiana. The concentration in the Central Louisiana Cut-over Pine Area and the Cut-over Flat Woods Area is due not so much to a large number of trees, but to the fact that the acres in harvested cropland is small. Both the acreage in harvested cropland and the number of trees is large in the North Louisiana Upland Cotton Area.

DESCRIPTION OF THE PEACH ENTERPRISE ON THE FARMS SURVEYED

The study of commercial peach orchards in 1944 included 31 farmers who were producing enough peaches to be considered of commercial importance. The cooperating farmers had been growing peaches from 4 to 30 years, the average, being about 12 years. No interview was made if less than 2 acres of peaches were in the orchard. The orchards were located in Lincoln, Claiborne, and Webster Parishes.

DESCRIPTION OF THE FARMS

The orchards studied were on farms typical in organization of the North Louisiana Upland Cotton Area but larger than average. There was an average of 207 acres per farm. Of this acreage, 69 acres were used for cultivated crops, 41 acres were classed as idleland, 54 acres were in pasture, and 43 acres were in woods and waste, table 2. The crop and livestock organization on the farms studied is also given in table 2.

TABLE 2. LAND USE, CROP AND LIVESTOCK ORGANIZATION FOR THE 31 FARMS STUDIED, NORTH LOUISIANA UPLAND COTTON AREA, 1944.

Land Use

Use	*Acres*
Cropland	69
Idle land	41
Pasture	54
Woods and waste	43
Total acres per farm	207

Livestock Organization

Kind	*Number*
Workstock	4
Dairy cows	4
Other cattle	11
Brood sows	1
Hogs raised	12
Poultry flock	50
Chickens raised	104

Cropping System

Crop	*Acres*
Cotton	22.0
Corn	20.2
Peanuts	1.1
Watermelons	7.3
Oats	4.0
Truck crops	1.2
Sweet Potatoes	.6
All other crops	.3
Orchard	12.3
Peaches	(10.1)
In-production	(4.8)
Pre-production	(5.3)
Total cropland harvested	69.0

The farms are similar to other farms in the area in that cotton and corn are the principal crops grown. The principal difference of these farms studied to other farms of similar size is the importance of commercial orchards—principally peaches.

IMPORTANCE OF THE PEACH ENTERPRISE

Peaches are an important enterprise on these farms. With an average of 10.1 acres of peaches per farm the enterprise assumes a position almost equal to that of cotton. Of the 10.1 acres in peaches, however, only 4.8 acres were 4 years or older—which means that less than one-half of the acreage in 1944 was in production. With over one-half of the acreage in young orchards the indications are that the enterprise is being expanded.

TABLE 3. THE AVERAGE AGE OF PEACH TREES, 31 ORCHARDS, NORTH LOUISIANA UPLAND COTTON AREA, 1944.

Age Group Years	*Number of Trees*	*Percent*	
0- 1	5,240	21	58
2- 3	9,335	37	
4- 5	4,575	18	42
6- 7	3,618	14	
8- 9	1,385	6	
10-12	405	2	
12-15	300	1	
15 and over	265	1	
TOTAL	25,123	100	

TABLE 4. PRINCIPAL VARIETIES OF PEACHES AS REPORTED BY FARMERS, 31 ORCHARDS, NORTH LOUISIANA UPLAND COTTON AREA, 1944.

Variety	*Number of Trees*	*Percent of Total*
Elbertas, all	11,608	46
Hale	6,202	25
Belle of Georgia	1,575	6
Golden Jubilee	1,276	5
Indian Cling	405	2
Red Bird	402	2
Halberta Giants	200	1
Fair's Beauty	190	1
May Flower	138	0
Mamie Ross	95	0
Carman	75	0
Unclassified[1]	2,957	12
TOTAL	25,123	100

[1] Those varieties listed as unclassified include Yellow Harvest, Alton, Spencer, Krumel, Heath Cling, Betsie Ross, and other.

The Average Age of Trees: The average age of peach trees is given in table 3. On the basis of the age of trees it appears that even a higher proportion of the trees have not reached the productive age as indicated by the acreages. Fifty-eight percent of the trees were less than 4 years old in 1944 and only 42 percent were in full production. The reason for a higher proportion of the trees being in the pre-production age group than is indicated by the acreage is that many young trees have been planted in the older orchards to replace unproductive or dead trees.

Disposition of the Crop: The average gross income per farm from peaches in 1944 was $918.98, and ranged from $0 to $6,750 per orchard. Even though peach production is primarily commercial on these farms, considerable quantities are used for home consumption. Home consumption is relatively more important on those farms with orchards less than 2 acres, however.

On a state basis for the total production, the cash sales of peaches amounted to 45 percent of the total farm value of the peach crop. This left 55 percent of the total value for consumption at home.[1] As the peach enterprise increases in commercial importance, a smaller proportion of the total value of the crop will be consumed at home.

VARIETIES OF PEACHES

The principal variety of peaches found in the orchards surveyed was the Elberta, which accounted for 46 percent of all trees, table 4. Other important varities were the J. H. Hale, Belle of Georgia, and Golden Jubilee in the order named.

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[1] Calculated from data obtained from "Production, Prices, and Value of Selected Crops, Livestock and Livestock Products in Louisiana, 1910-44," J. P. Montgomery, Department of Agricultural Economics, Mimeograph Circular No. 49.

MORTALITY OF TREES

On the basis of past experience, estimates were obtained from farmers on the probable loss of trees by age groups, table 5. From these estimates it was found that out of 100 trees planted, about 81 trees were expected to be in production the fourth year. At the end of the tenth year, they expected about 52 of the original trees to be living and productive. Very few trees were expected to be productive after the fifteenth year.

TABLE 5. THE AVERAGE ESTIMATED MORTALITY OF PEACH TREES AS REPORTED BY FARMERS, 31 ORCHARDS, NORTH LOUISIANA UPLAND COTTON AREA, 1944.

Age of Trees	*Percent Mortality*	*Per 100 Trees No. left*
0-1	9	91
2	5	86
3	5	81
4	4	77
5	4	73
6	4	69
7	4	65
8	4	61
9	4	57
10	5	52
11	5	47
12	5	42
13	5	37
14	5	32
15	7	25
16	7	18
17	7	11
18	7	4

These same farmers were asked another question on the productive life of trees. An average of these estimates indicated that about 10 years was considered the average productive life of trees in the area.

THE COST OF ESTABLISHING A COMMERCIAL PEACH ORCHARD[2]

The production of peaches is different from the usual annual crops in that peach trees do not normally bear the first crop of peaches until about the fourth year. Since the development of orchards is a long time proposition and entails high capital requirements in relation to most other crops, it appears that prospective growers would be interested in the usual practices, requirements, and development costs of commercial orchards.

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[2] This section deals only with the economic aspects of orchard development. For a comprehensive treatment of general agronomic considerations of orchard development the reader is referred to the North Carolina State College Agricultural Extension Service Circular No. 220, "Establishing a Commercial Peach Orchard" by H. R. Niswonger and L. P. Watson.

TABLE 6. USUAL OPERATIONS, MAN, TRACTOR, AND MULE HOURS REQUIRED PER ACRE TO ESTABLISH PEACH ORCHARDS IN THE NORTH LOUISIANA UPLAND COTTON AREA.

Usual Operations	*Tractor Operated Farms*[1]				*Mule Operated Farms*[2]			
	Times	*Hours per acre*			*Times*	*Hours per acre*		
	Over	*Man*	*Tractor*	*Mule*	*Over*	*Man*	*Tractor*	*Mule*
First Year								
Set trees[3]	1	10.5	2.0	....	1	21.5	....	14.0
Breaking[4]	1	1.2	1.2	....	1	7.4	....	8.5
Applying Fertilizer	1-2	1.4	....	....	1-2	1.4	....	....
Cultivating[5]	5	5.0	....	5.0	4	4.1	....	4.1
Hoeing	2	5.0	....	....	2	4.8	....	....
Cover crop[6]	1	3.3	1.5	....	....	....	....	....
TOTAL		26.4	4.7	5.0		39.2		26.6
Second Year								
Resetting[7]	1	.8	....	....	1	.8	....	....
Pruning	1	4.2	....	.5	1	3.4	....	....
Spray-oil Emulsion[8]	1	6.8	....	4.6	1	6.8	....	4.6
Discing	4	4.3	4.3	....	1	3.3	.6	5.4
Breaking[4]	1	3.7	.7	4.0	1	6.0	....	6.7
Applying Fertilizer	1-2	1.9	....	....	1-2	1.9	....	....
Cultivating[5]	3	2.7	....	2.7	4	3.5	....	3.5
Hoeing	2	4.9	....	....	2	4.9	....	....
Cover crop[6]	1	3.5	1.5	.2	....	....	....	....
TOTAL		32.8	6.5	12.0		30.6	.6	20.2
Third Year								
Resetting[7]	1	.9	....	....	1	.9	....	....
Pruning	1	6.3	.2	.8	1	5.3	....	1.0
Spray-Oil Emulsion[8]	1	9.0	....	6.0	1	9.0	....	6.0
Discing	5	5.6	5.6	....	1	2.2	.4	3.9
Breaking[4]	....	....	....	....	1	6.7	....	7.3
Applying Fertilizer	1	1.8	....	....	1	1.8	....	....
Cultivating[5]	....	....	....	....	3	4.5	....	4.5
Hoeing	1-2	3.6	....	....	1-2	4.4	....	....
Cover crop[6]	1	3.5	1.5	....	....	....	....	....
TOTAL		30.7	7.3	6.8		34.8	.4	22.7
TOTAL, 3 YEARS		89.9	18.5	23.8		104.6	1.0	69.5

[1] Fourteen farms operating with tractors.

[2] Seventeen farms operating with mules.

[3] The most usual spacing was 21 x 21 feet or 100 trees per acre. The trees were generally planted on clean land after a fall crop. The requirements include laying off the rows, digging holes or trenches and setting the trees.

[4] Flatbreaking as a rule is associated with the interplanted crop, but for purposes here it is included as an orchard practice. Frequently flatbreaking takes the place of discing, mainly on mule operated farms.

[5] The requirements are for cultivating around the trees only. It is assumed that cultivations of the intertilled crop are chargeable to that crop.

[6] Includes requirements for applying phosphate.

[7] Resetting approximately 9 trees per acre in the second year and 5 in the third year.

[8] Applications based on the use of a barrel spray.

The commercial orchards that were studied in the North Louisiana Upland Cotton Area have been described, and the following information on the establishment of orchards is based on the usual method of orchard management as practiced by farmers now growing peaches in the area.

LABOR AND POWER REQUIREMENTS

The usual labor and power requirements for developing an acre of peaches are given by operations and summarized for the three year period required to bring peaches into production in table 6.

Farmers are mechanizing their farms rapidly in the hill areas of the state, and nearly half of the orchards studied were on farms where tractors were operated. The type of power used in doing farm work influences the amount of labor required as well as the actual cost of performing various operations. Since the trend toward farm mechanization is expected to continue at an accelerated rate, the usual operations, man, tractor, and mule hour requirements are summarized separately for tractor operated farms and mule operated farms.

On farms where tractors were operated, it required 88.9 man hours of work, 18.5 tractor hours, and 23.8 mule hours to develop an acre of orchard through the third year. This compares with 104.6 man hours, 1.0 tractor hour, and 69.5 mule hours on farms operated with mules. As a rule the farmers operating with tractors were more careful and efficient in performing recommended practices. For example, tractor farmers followed the practice of planting winter cover crops in the orchard, while this was not a usual practice on other farms.

The usual operations presented here are typical ones that are followed in the area studied. They are not necessarily the recommended practices, or do they represent the only operations performed on each individual farm. The usual operations listed and the rates of performing them represent the prevalent pattern of orchard development and are the basis for determining labor and power requirements.

DEVELOPMENT COSTS

It has been shown that considerable variation in labor and power requirements occur under different farm conditions. Since this is so, the cost of establishing an acre of peaches is given for those farms that operate with tractor power and for those operating mainly with mule power. The cost of orchard development is presented in table 7 with cost rates as existing in 1944 and with cost rates as existing in 1935-39.

Development Costs on Tractor Operated Farms: The cost of establishing an acre of peaches at 1944 prices was $102.39 for three years. The development cost was $38.53 in the first year, $31.29 in the second year, and $32.57 in the third year.

TABLE 7. THE USUAL COST OF ESTABLISHING AN ACRE OF PEACHES, NORTH LOUISIANA UPLAND COTTON AREA[1]

Item	Unit	Price per unit, 1944	Normal Prices[2]	Tractor Operated Farms			Mule Operated Farms		
				Quantity	Cost 1944	1935-39 cost	Quantity	Cost 1944	1935-39 cost
		dol.	dol.		dol.	dol.		dol.	dol.
First Year									
Trees	no.	.16[3]	.14	100.00	16.00	14.00	100.00	16.00	14.00
Fertilizer[4]	cwt.	1.90	1.57	1.10	2.09	1.73	1.00	1.90	1.57
Cover crop	lbs.	.10	.08	29.00	2.90	2.32	—	—	—
Fertilizer-cover crop	cwt.	1.19	.98	2.00	2.38	1.96	—	—	—
Man labor	hrs.	.24	.10	26.40	6.34	2.64	39.20	9.41	3.92
Mule work[5]	hrs.	.22	.15	5.00	1.10	.75	26.60	5.85	3.99
Tractor work[6]	hrs.	.47	.43	4.70	2.21	2.02	—	—	—
Equipment cost[7]	—	—	—	—	1.63	1.29	—	1.68	1.33
Land charge[8]	—	—	—	—	1.26	1.26	—	1.26	1.26
Interest[9]	—	—	—	—	1.12	.87	—	1.12	.80
Miscellaneous	—	—	—	—	1.50	1.08	—	1.00	.72
TOTAL					38.53	29.92		38.22	27.59
Second Year									
Trees	no.	.16[3]	.14	9.00	1.44	1.26	9.00	1.44	1.26
Fertilizer[4]	cwt.	1.90	1.57	1.25	2.37	1.96	1.14	2.17	1.79
Materials-Oil Emulsion	gal.	.60	.50	1.00	.60	.50	1.00	.60	.50
Cover crop	lbs.	.10	.08	29.00	2.90	2.32	—	—	—
Fertilizer-cover crop	cwt.	1.19	.98	2.00	2.38	1.96	—	—	—
Man labor	hrs.	.24	.10	32.80	7.87	3.28	30.60	7.34	3.06
Mule work[5]	hrs.	.22	.15	12.00	2.64	1.80	20.20	4.44	3.03
Tractor work[6]	hrs.	.47	.43	6.50	3.06	2.80	.60	.28	.26
Equipment cost[7]	—	—	—	—	2.15	1.71	—	1.55	1.22
Land charge[8]	—	—	—	—	1.26	1.26	—	1.26	1.26
Interest[9]	—	—	—	—	3.12	2.34	—	2.84	1.99
Miscellaneous	—	—	—	—	1.50	1.08	—	1.00	.72
TOTAL					31.29	22.27		22.92	15.09

TABLE 7 (Continued). THE USUAL COST OF ESTABLISHING AN ACRE OF PEACHES, NORTH LOUISIANA UPLAND COTTON AREA[1]

Item	*Unit*	*Price per unit, 1944*	*Normal Prices*[2]	*Tractor Operated Farms* *Quantity*	*Tractor Operated Farms* *Cost 1944*	*Tractor Operated Farms* *1935-39 cost*	*Mule Operated Farms* *Quantity*	*Mule Operated Farms* *Cost 1944*	*Mule Operated Farms* *1935-39 cost*
		dol.	*dol.*		*dol.*	*dol.*		*dol.*	*dol.*
Third Year									
Trees	no.	.16[3]	.14	5.00	.80	.70	5.00	.80	.70
Fertilizer[4]	cwt.	1.90	1.57	1.85	3.52	2.90	1.82	3.46	2.85
Materials-Oil Emulsion	gal.	.60	.50	1.70	1.02	.85	1.70	1.02	.85
Cover Crop	lbs.	.10	.08	29.00	2.90	2.32	—	—	—
Fertilizer-cover crop	cwt.	1.19	.98	2.00	2.38	1.96	—	—	—
Man labor	hrs.	.24	.10	30.70	7.37	3.07	34.80	8.35	3.48
Mule work[5]	hrs.	.22	.15	6.80	1.50	1.02	22.70	4.99	3.40
Tractor work[6]	hrs.	.47	.43	7.30	3.43	3.14	.40	.19	.17
Equipment cost[7]	—	—	—	—	2.09	1.65	—	1.60	1.26
Land charge[8]	—	—	—	—	1.26	1.26	—	1.26	1.26
Interest[9]	—	—	—	—	4.80	3.54	—	4.12	2.82
Miscellaneous	—	—	—	—	1.50	1.08	—	1.00	.72
TOTAL					32.57	23.49		26.79	17.51
TOTAL FOR 3 YEARS					102.39	75.68		87.93	60.19

---

[1] Based on the usual method of establishing peach orchards on the 31 farms studied.

[2] Average prices 1935-39.

[3] Average prices paid for trees in the period 1940-44.

[4] Average applications of those using commercial fertilizers and of those using nitrogen fertilizer only.

[5] Mule costs based on unpublished data obtained in the North Louisiana Upland Cotton Area for 1944.

[6] Tractor costs based on unpublished data obtained in the North Louisiana Upland Cotton Area for 1944.

[7] Equipment costs based on unpublished data obtained in the North Louisiana Upland Cotton Area for 1944.

[8] Land charge based on estimated value of cropland at 5 percent plus the average real estate tax per acre.

[9] Interest figured at 6 percent on the average accrued cost of establishing one acre of peaches.

Since the price level was considerably higher in 1944 than in the previous years when most orchards were established, the normal cost of orchard development is presented and based upon prices that prevailed in the period 1935-39. The cost of establishing an acre of peaches in this period was $75.68 for three years. The development cost was $29.92 in the first year, $22.27 in the second year, and $23.49 in the third year.

In terms of actual cost, it cost $26.71 or slightly over one-third more to established an acre of peaches at 1944 prices than in the pre-war period 1935-39.

Development Costs on Mule Operated Farms: The cost of establishing an acre of peaches at 1944 prices was $87.93 for three years. The development cost was $38.22 in the first year, $22.92 in the second year, and $26.79 in the third year. The cost of establishing an acre of peaches is less on the farms operated with mules only than on those farms with tractors. The reason is due not so much to the type of power used but to the fact that fewer desirable orchard practices are performed on the farms operating with mules. For example it was not a general practice to plant winter cover crops on these farms.

As in the previous situation, normal costs of orchard development were obtained by applying the average price of cost factors for the period 1935-39. The normal cost of development in this period was $60.19 for three years. The development cost was $27.59 in the first year, $15.09 in the second year, and $17.51 in the third year. The cost of establishment was $27.74 or 46 percent more on mule operated farms in 1944 than in the period 1935-39.

As compared with farms operating with tractors the cost of development at 1944 prices is about 85 percent as much. The comparative cost, however, is confusing because better orchard practices were followed on those farms using tractors than those using mules only.

Differences in the Cost of Orchard Development: The cost of power, equipment, and labor for three years was $41.39 in 1944 on farms operating with tractors, and $45.68 on farms operating with mules. Higher costs on mule operated farms are due to higher man labor and mule work requirements on farms operating with mules. Development cost was relatively higher in 1944 than in 1935-39 on mule operated farms, mainly because of higher costs of man labor and mule power in 1944 as compared with the rates prevailing in 1935-39.

The cost of trees account for high initial costs in the first year, but this cost is about the same regardless of the type of power.

Higher material costs for fertilizer were found on tractor farms. The principal difference is due to the fact that farmers operating with tractors plant cover crops and those using mules do not.

COSTS AND RETURNS FROM THE PEACH ENTERPRISE

There prevails considerable interest in the possibilities of expanding and developing the peach enterprise both on the part of farmers and agricultural leaders in those areas where the production of peaches appears feasible. In order to evaluate the economic possibilities of peach production in Louisiana the following information should be helpful: (1) Man labor and power requirements for peach production, (2) The cost of producing peaches in 1944, (3) The cost of producing peaches in pre-war years, for example during the period 1935-39, (4) The comparative cost of producing peaches when tractors are being used and where mules are being used, and (5) The average returns per bushel, per acre, and per hour of work for each of the above situations.

LABOR AND POWER REQUIREMENTS

The usual operations for an orchard in production with man labor and power requirements per acre of peaches are summarized in table 8. These requirements are based on an acre of peaches of 100 trees. On tractor operated farms with expected yields of 1.06 bushels per tree or 106 bushels an acre about 114.7 man hours, 7.3 tractor hours, and 33.4 mule hours are required to grow and harvest an acre.

TABLE 8. USUAL OPERATIONS, MAN, TRACTOR, AND MULE HOURS REQUIRED PER ACRE OF PEACHES IN PRODUCTION, NORTH LOUISIANA UPLAND COTTON AREA.

Usual Operations	*Tractor Operated Farms*[1]				*Mule Opperated Farms*[2]			
	Times Over	*Hours per acre*			*Times Over*	*Hours per acre*		
		Man	*Tractor*	*Mule*		*Man*	*Tractor*	*Mule*
Resetting[3]	1	.5	—	—	1	.5	—	—
Pruning	1	11.1	—	3.0	1	10.7	—	3.2
Spray-Oil emulsion[4]	1	11.5	—	7.7	1	11.5	—	7.7
Discing	4	5.8	5.8	—	3	7.4	1.7	11.4
Applying fertilizer	1-2	2.1	—	—	1-2	2.2	—	—
Hoeing	1-2	3.0	—	—	2	5.5	—	—
Spray-Arsenate-sulphur[5]	3	33.0	—	21.0	3	33.0	—	21.0
Harvest[6]	4-5	44.2	—	1.7	4-5	35.0	—	1.7
Cover crop[7]	1	3.5	1.5	—	—	—	—	—
TOTAL, ALL OPERATIONS		114.7	7.3	33.4		105.8	1.7	45.0

[1] Fourteen farms operating with tractors.
[2] Seventeen farms operating with mules only.
[3] The most usual spacing was 21 x 21 feet or 100 trees per acre. The requirements include digging holes or trenches and setting trees.
[4] Applications based upon the use of a barrel spray.
[5] Spraying and dusting. Applications based upon the use of a barrel spray.
[6] Producers estimated that on an average one man usually picked about 24 bushels of peaches in a 10-hour day or 2.4 bushels per hour. The average yield on which the labor requirements are based in this case was 106 bushels an acre of 1.06 bushels per tree for tractor operated farms and 84 bushels an acre or .84 bushel per tree on mule operated farms.
[7] Includes requirements for applying phosphate.

Where mules are the principal source of power, the expected yield per tree and per acre was slightly lower with .84 bushel per tree or 84 bushels an acre. Usually 105.8 hours of man labor, 1.7 hours of tractor work, and 45.0 hours of mule work are required to grow and harvest an acre.

THE COST OF PRODUCING PEACHES

The cost of producing an acre of peaches at 1944 prices and at 1935-39 prices is summarized in table 9. Since the type of power used also affects the cost of performing various farm jobs, the production cost when tractors are the main source of power is compared with that when mules furnish most of the power.

The data on costs and returns presented in this section of the report are based on methods of orchard management as practiced in the past and do not in all cases represent desirable or recommended orchard practices. One exception to the foregoing is that the costs and returns per acre are calculated on the basis of maintaining a full stand of trees. Where less than a full stand of trees is found, proportional adjustments should be made in costs in relation to yields.

Cost Per Acre and Per Bushel in 1944: The cost per acre for growing and harvesting an acre of peaches on tractor farms was $80.96 and the average yield was 1.06 bushels per tree or 106 bushels per acre. On mule operated farms the cost in 1944 was $69.53. The average yield was .84 bushel per tree or 84 bushels an acre. The cost per bushel was $0.76 on tractor farms and $0.83 on those farms operating with mules. Production costs were unusually high in 1944 because of high wage rates and high prices for other cost items, table 9.

Production costs per acre were higher on tractor farms for several reasons. Better orchard practices were followed in regard to winter cover crops, fertilization, cultivation, etc. Production costs per bushel, however, were lower on these farms despite higher per acre costs because of higher yields per acre.

These costs do not include the cost of containers because as a rule the demand for peaches has far exceeded the supply and buyers have furnished containers the past two years. If containers had been purchased by the farmer the per acre cost on tractor farms would have been increased about $25.44 to $106.40 or $1.00 a bushel. On mule operated farms the added cost for containers would have been $20.16 increasing the per acre cost to $89.69 or $1.07 a bushel.

Cost Per Acre and Per Bushel in 1935-39: Since the price level is of extreme importance in determining the cost of production, it is important to examine the cost of producing peaches during a normal period, such as the period 1935-39. Material requirements do not change much from year to year and the cost per acre for 1935-39 was obtained by applying cost rates that prevailed during this time. In determining per bushel

TABLE 9. THE COST OF PRODUCING AN ACRE OF PEACHES IN THE NORTH LOUISIANA UPLAND COTTON AREA

Item of cost	*Unit*	*Price per unit 1944*	*Prices per unit 1935-39*	*Tractor Operated Farms*			*Mule Operated Farms*		
				Quantity	*Cost 1944*	*Cost 1935-39*[1]	*Quantity*	*Cost 1944*	*Cost 1935-39*[1]
		Dol.	*Dol.*		*Dol*	*Dol.*		*Dol.*	*Dol.*
Man labor	hrs.	.24	.10	114.70	27.53	11.15	105.80	25.39	10.41
Mule work[2]	hrs.	.22	.15	33.40	7.35	5.01	45.00	9.90	6.75
Tractor work[2]	hrs.	.47	.43	7.30	3.43	3.14	1.70	.80	.73
Equipment use[2]	—	—	—	—	3.02	2.34	—	2.55	2.05
Fertilizer	cwt.	1.90	1.57	2.51	4.77	3.94	2.31	4.39	3.63
Fertilizer-cover crop	cwt.	1.19	.98	2.00	2.38	1.96	—	—	—
Cover crop seed	lbs.	.10	.08	29.00	2.90	2.32	—	—	—
Materials-Oil Emulsion	gal.	.60	.50	3.40	2.04	1.70	3.40	2.04	1.70
Materials—Arsenate, Lime, Sulphur[3]	—	—	—	—	3.06	2.41	—	3.06	2.42
Land charge[4]	—	—	—	—	1.26	1.26	—	1.26	1.26
Interest on orchard[5]	—	—	—	—	6.14	4.54	—	5.27	3.61
Interest on growing costs[6]	—	—	—	—	1.84	1.18	—	1.60	.98
Reserve for depletion[7]	—	—	—	—	10.24	7.57	—	8.79	6.02
Miscellaneous[8]	—	—	—	—	5.00	3.96	—	4.50	3.56
TOTAL PRODUCTION COST[9]					80.96	52.48		69.55	43.12
Average yield per acre in bushels					106	102		84	80
Average cost per bushel					$ 0.76	$ 0.51		$ 0.83	$ 0.54
Average price per bushel					2.62	1.09		2.62	1.09
Net returns per bushel					1.86	0.58		1.79	0.55
Net returns per acre					196.76	58.70		150.53	44.08
Average returns per hour of labor					1.96	0.63		1.66	0.52

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[1] Man labor requirements corrected to normal yields, 111.5 hours on tractor operated farms and 104.1 hours on mule operated farms.

[2] Cost rates obtained from an unpublished study of farm mechanization made in 1944 in the North Louisiana Upland Cotton Area.

[3] Based on the usual method of spraying. Several farmers used dust rather than spray.

[4] Land charge based upon the farmer's estimate of value and interest at 5 percent plus taxes.

[5] Interest on orchard figured at 6 percent of the establishment cost.

[6] Interest on growing cost figured at 6 percent of the growing costs for 6 months.

[7] Reserve for depletion is considered a production cost and was determined by dividing the establishment cost by the estimated productive life of the orchard.

[8] Includes the cost of trucks, transportation, and other miscellaneous items of expense.

[9] This production cost does not include any cost for containers. As a rule buyers furnish the containers, particularly so in 1943 and 1944.

costs normal yields as estimated by the cooperating farmers were used. Their estimate of normal yield was only slightly less than actual yields in 1944.

The cost of growing and harvesting an acre of peaches on tractor farms in 1935-39 was $52.48. The estimated normal yield was 1.02 bushels per tree or 102 bushels an acre. On mule operated farms it cost $43.12 to grow and harvest an acre. The estimated normal yield was .80 bushel per tree or 80 bushels an acre. The cost per bushel on tractor farms was $0.51 a bushel and on mule farms $0.54.

If it had been necessary for farmers to purchase containers the cost per acre on tractor operated farms would have been increased $18.36 to $70.84 and on mule operated farms it would have been increased $14.40 to $57.52, the per bushel costs would have been increased proportionally to $0.69 a bushel with tractor power and $0.72 with mule power.

Even though normal yields were a little below those in 1944, it is possible to get an approximate comparison of 1935-39 costs with those of 1944. On tractor farms the per acre cost was 54 percent higher in 1944 than in 1935-39. On mule farms the per acre cost was 61 percent higher. The per bushel cost was 51 percent more in 1944 on farms using tractors and 54 percent more on those using mules.

NET RETURNS FROM THE ENTERPRISE

Prospective producers of peaches are interested in the probable returns from the enterprise. The development and annual production costs are important but not any more so than yields and prices. Net returns from the enterprise are given here for 1944 and also for the period 1935-39. Variations in yields and prices are taken up in another section of this report.

Net Returns in 1944: The average price received for peaches at the farm in 1944 without containers was $2.62 a bushel. This is the second highest price received for peaches on record. Data on returns per bushel and per acre are given at the bottom of table 9.

On the farms operating with tractors the average yield was 1.06 bushels per tree; the net return, $1.85 per bushel, $196.56 per acre, and $1.96 per hour of labor. On the farms operating with mules the yield was .84 bushel per tree; the net return, $1.79 per bushel, $150.54 per acre, and $1.66 per hour of labor.

It must be remembered that the year 1944 was extremely favorable as to price, and yields were above normal. Production costs were high, but because of the favorable conditions, the enterprise was more profitable than could be anticipated over a period of years.

Net Returns in 1935-39: The pre-war period 1935-39 was a normal period in regard to cost-price relationships and to yields. From the standpoint of evaluating the enterprise as an alternative in cropping systems or as a supplementary source of income, this period furnishes more reliable basis.

The net return per bushel on tractor farms was $0.58, per acre $58.68, and per hour of labor $0.63. On mule farms the net return per bushel was $0.55, per acre $44.08, and per hour of labor $0.52. On farms operating with tractors the normal yield was estimated to be 1.02 bushels per tree as compared with .80 bushel per tree on those operating with mules.

COSTS AND RETURNS IN LOUISIANA COMPARED WITH OTHER STATES

A study of the peach enterprise in western New York[3] of 120 orchards in 1936 shows a per acre cost, excluding containers, of $80.76, and a net return per acre of $52.61. The yield per acre was 120 bushels, the cost per bushel was $0.67, the return per hour of labor was $0.89 and 97 hours of man labor were required to grow and harvest an acre, table 10.

An Arkansas study on Production Costs and Market Distribution made in 1925 is not strictly comparable to the 1935-39 period, or to 1944.[4] The general price level in 1925 was above that in 1935-39 and below that of 1944. In the Ozark Foothills section production costs, excluding containers, was $76.24, the yield 100 bushels an acre, and the cost per bushel

TABLE 10. THE COSTS AND RETURNS FROM THE PEACH ENTERPRISE IN LOUISIANA COMPARED WITH OTHER STATES, SELECTED YEARS.

State	*Year*	*Yield*	*Hours man labor*	*Cost per acre*[3]	*Cost per bushel*[3]	*Net returns per acre*[3]	*Returns per hour of labor*[3]
		bu.	*hrs.*	*dol.*	*dol.*	*dol.*	*dol.*
Louisiana							
Tractor Operated Farms	1944	106	114.7	81.11	0.77	196.56	1.95
Mule Operated Farms	1944	84	105.8	69.54	0.83	150.54	1.66
Tractor Operated Farms	1935-39	102	111.5	52.50	0.51	58.68	0.63
Mule Operated Farms	1935-39	80	104.1	43.12	0.54	44.08	0.52
New York[1]							
All farms	1936	120	97	80.76	0.67	52.61	0.89
Arkansas[2]							
Ozark Foothills	1925	100	——	76.24	0.76	——	—
Highland Area	1925	125	——	93.58	0.75	——	—

[1] *The Peach Enterprise in Western New York*, Harrell F. DeGraff, Agricultural Experiment Bulletin, No. 710.

[2] *Production Costs and Market Distribution of Arkansas Peaches*, C. O. Brannen, Agricultural Experiment Station Bulletin, No. 207.

[3] Excludes the cost of containers.

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[3] "The Peach Enterprise in Western New York," Harrell F. DeGraff, Agricultural Experiment Station Bulletin, No. 710.

[4] "Production Costs and Market Distribution of Arkansas Peaches," C. O. Brannen, Agricultural Experiment Station Bulletin, No. 207.

$0.76. In the Highland area production costs per acre, excluding containers was $93.58, the yield 125 bushels an acre, and the cost per bushel $0.75. The production cost per bushel was slightly lower than that found in Louisiana in 1944, but considerably higher than that during the period 1935-39. If the studies had been made in the same year, the data indicate that costs per bushel would not have varied widely.

In analyzing the cost and returns from the peach enterprise it should be remembered the extreme variations in cost-price-yield relationships occur from season to season. Although there is considerable variation in orchard management within the state and from one producing area to another, striking similarities are apparent when the Louisiana data are compared to comparable studies made in other states, table 10.

SOME OBSERVATIONS ON THE ENTERPRISE IN LOUISIANA

The production of peaches requires the close supervision of the farm operator and is more complicated than the production of most annual farm crops. The enterprise is highly specialized and for economical production, it is necessary to follow recommended orchard practices as to choice of soil, fertilization, cover crops, pruning, spraying, etc. Successful production in other words requires considerable managerial capacity.

TABLE 11. The Estimated Number of Trees, Production, and Yield Per Tree for the United States and Louisiana, by Periods, 1910-44.

Period	*Louisiana* Number of trees	Bushels harvested	Yield per tree	*United States* Number of trees	Bushels harvested	Yield per tree
	(*thousands*)	(*thousands*)	(*bushels*)	(*thousands*)	(*thousands*)	(*bushels*)
1910-14	803	423	.53	88,981	44,167	.50
1915-19	553	397	.72	74,500	47,043	.63
1920-24	395	197	.50	64,269	46,731	.73
1925-29	352	191	.54	61,100	53,553	.88
1930-34	357	246	.69	57,142	53,693	.94
1935-39	405	291	.72	51,255	55,919	1.09
1940-44	426	318	.75	49,709	62,359	1.25

Based on U. S. Census and data from the Crop Reporting Board, Bureau of Agricultural Economics.

Yield of Peaches

It has been observed that much better orchard practices are followed where the orchard is of commercial importance than in home orchards. Since considerable numbers of bearing trees and trees less than bearing age are in home orchards, it is to be expected that the best scientific methods of handling the trees is not the usual practice in Louisiana. This becomes evident when the average yield per tree in Louisiana is compared with national averages, table 11. The average yield per tree is considerably lower in Louisiana than the average yield for the United States, 0.72 bushel per tree in 1935-39 as compared with 1.09 bushels for the country as a whole. The yield per tree in 1944 for the 31 commercial orchards in Louisiana was 1.06 bushels on tractor operated farms and 0.84 bushel on mule operated farms. The estimated normal yield was 1.02 bushels and 0.80 bushel, respectively. The yields of these commercial orchards are much nearer to national average yields.

THE PRODUCTION OF PEACHES

Production of peaches in any given year depends, of course, on the number of bearing trees and the yield per tree. Variation in production from year to year is vitally important in determining profits from the peach enterprise. Probably the most comprehensive measure of the variations in production is the published estimates of peach production over a period of years. Annual production estimates are valuable in determining the occurence and extent of poor production years.

Production in Louisiana: The production of peaches in Louisiana has been estimated annually since 1909 by the Crop Reporting Board of the Bureau of Agricultural Economics, figure 4. The total production of peaches since 1919 has declined from the level prevailing prior to that time due to the reduction in the number of bearing trees. Yields have been increased but not sufficiently to maintain production at the level prevailing in the period 1909-19.

Since 1930 there has been three years in which production has been less than 232,000 bushels. The three poor years were 1932 when only 122,000 bushels were harvested, 1937 when 232,000 bushels were harvested and 1943 when 176,000 bushels were harvested. The estimated yield per tree in 1932 was *0.34* bushel; 1937, *0.57* bushel; and 1943, *0.40* bushel. The largest production reported from 1930 to 1944 was 392,000 bushels in 1931, and the average production for the period was 294,000. Production was greater than 294,000 bushels in 8 of these years and less than the average in 6 years.

On the basis of annual production, it appears that about one out of every five years is a poor year for peaches in Louisiana. This generalization, however, does not hold true for every particular orchard in Louisiana, as individual orchards may fail completely in a particular year. The frequency of failures for a particular orchard may either be more or less than the average for the state.[5]

Production in the United States: The production of peaches in the United States varies much less from year to year than in Louisiana, figure 5. The average annual production for 14 years 1931-1944 was 57,325,000 bushels. In 6 of these years the annual production exceeded the average for the period and in 8 years the production was lower than the

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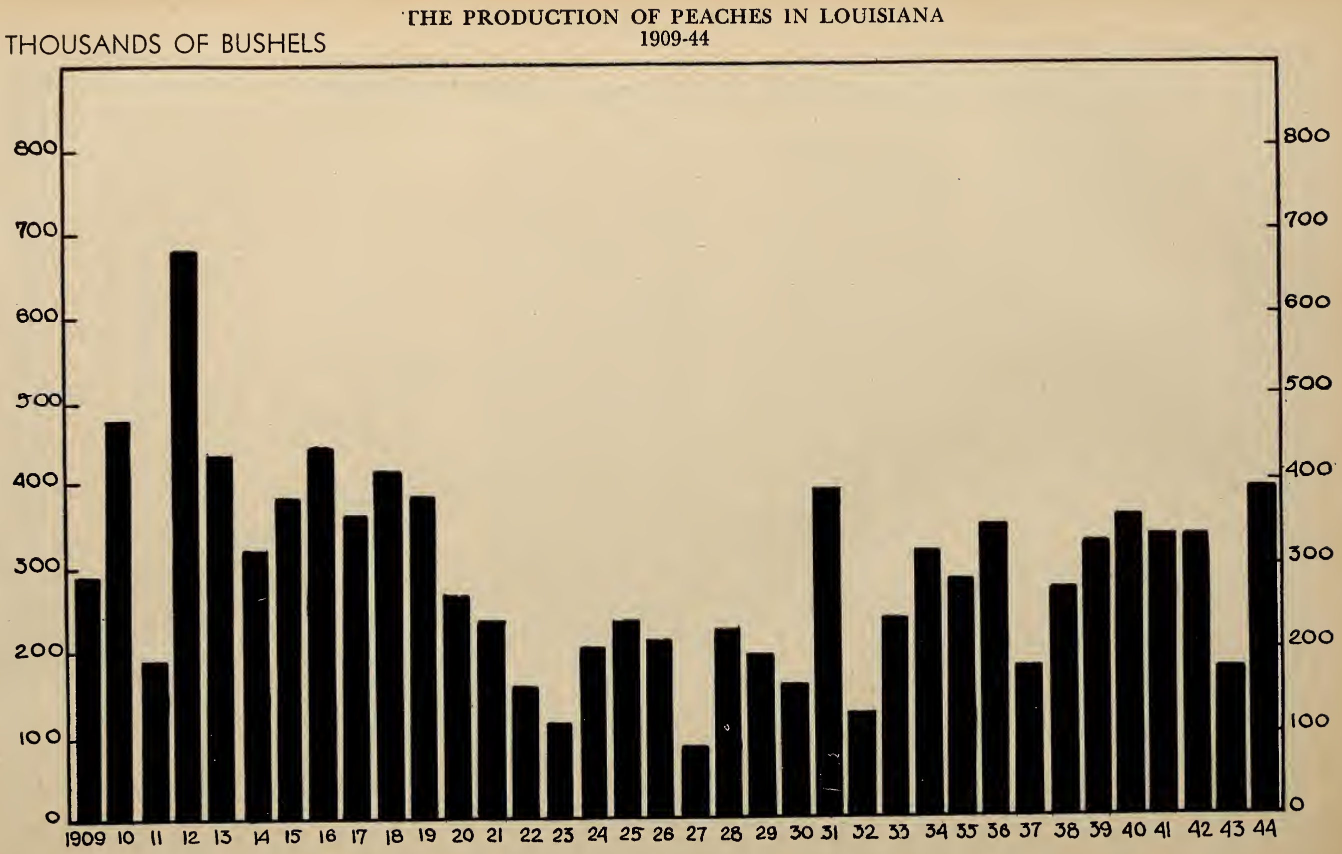
[5] Experimental work on peaches has been conducted at the North Louisiana Experiment Station for a number of years. Yields, of course, have varied widely from year to year but there is no record of a complete failure in the last 17 years.



THE PRODUCTION OF PEACHES IN LOUISIANA
1909-44

FIGURE 4.—The production of Peaches in Louisiana has been fair ly stable since 1931 with an average annual production of about 294 thousand bushels.

SOURCE: United States Department of Agriculture, Bureau of Agricultural Economics; Crop Reporting Board—August, 1942, Agricultural Statistics—1943, Louisiana Crop Report—1944.

average. The annual production ranged from 42,180,000 bushels in 1943 to 76,971,000 bushels in 1931.

PRICE OF PEACHES

The price received by farmers for peaches and the variation in prices from year to year is an important factor affecting the profits from the enterprise. The farm price per bushel in Louisiana follows a similar pattern to the price of peaches in the United States, however, the price in Louisiana usually is a little higher than that throughout the rest of the country, figure 6. The consumption of peaches in Louisiana is greater than the production and until the production of peaches in Louisiana exceeds local consumption, the farm price may be expected to exceed the price in surplus producing areas by the cost of transportation and handling.

The lowest price on record for Louisiana peaches was in 1934 when the average price per bushel was $0.75. This is the only year since 1916 that the price has been below $1.00 a bushel. Peaches sold for $1.00 a bushel in 1938 and 1940. Prices reached a new peak in 1943 and 1944, the average farm price being $3.10 in 1943 and $3.00 in 1944.

Higher prices in 1943 and 1944 have stimulated much interest on the part of farmers in Northern Louisiana in the possibilities of peach production. The information presented in this bulletin indicates that the peach enterprise when handled properly is profitable even with normal prices, but farmers should not go into the business on the basis of anticipating prices of $3.00 per bushel. The average price for the period 1935-39 was $1.09 a bushel. From 1931 to 1944, the average annual price exceeded $1.09 a bushel in 6 years and was less in 8 years.

The relationship of the general price level to the price of peaches is important for commercial peach producers to consider, figure 7. The Louisiana farm price of peaches follows pretty much the same pattern as that of all wholesale prices in the United States. During the '20's the price of peaches was high relative to the general price level. This relationship was reversed during the '30's and from 1933-42 the farm price of peaches was low in relation to other wholesale prices. Since 1942 the wartime demand has been great and peaches have been relatively high to the general level of all prices.

It is in periods like 1942-44 that there is much enthusiasm in expanding the enterprise. It is good business on the part of prospective producers to consider a much longer period than two or three years before making the long time commitments required in the production of peaches. Peach trees that are planted in 1945 cannot be expected to bear before 1949 and with usual orchard practices the normal bearing life of these trees would last about 10 years.

THE PRODUCTION OF PEACHES IN THE UNITED STATES, 1909-44

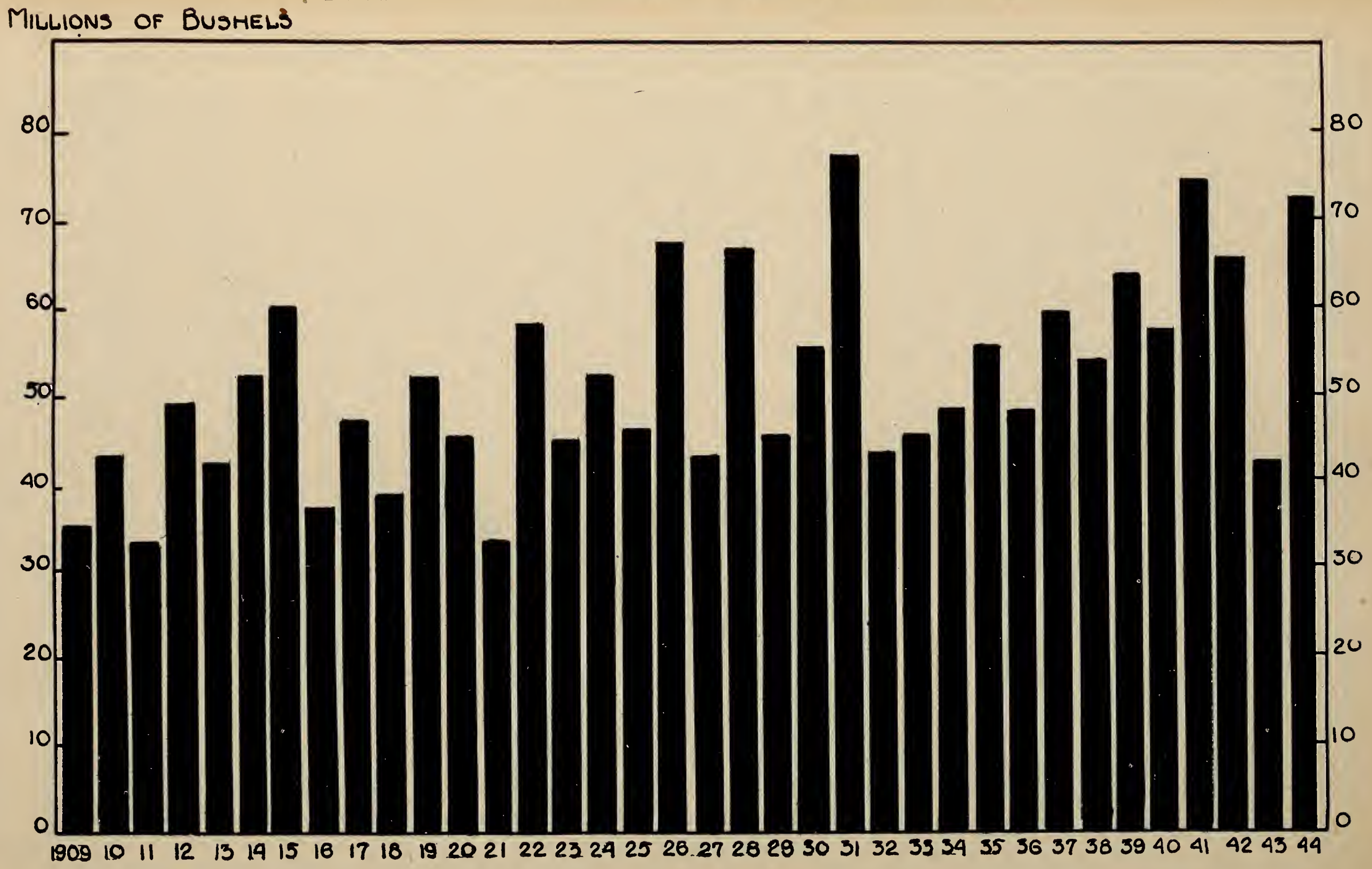


FIGURE 5.—There is less variation in production from year to year for the United States than for Louisiana. This is not due to the fact that production is more hazardous in Louisiana, but because a much smaller area is included.

SOURCE: United States Department of Agriculture, Bureau of Agricultural Economics: Crop Reporting Board—August, 1942. Agri-

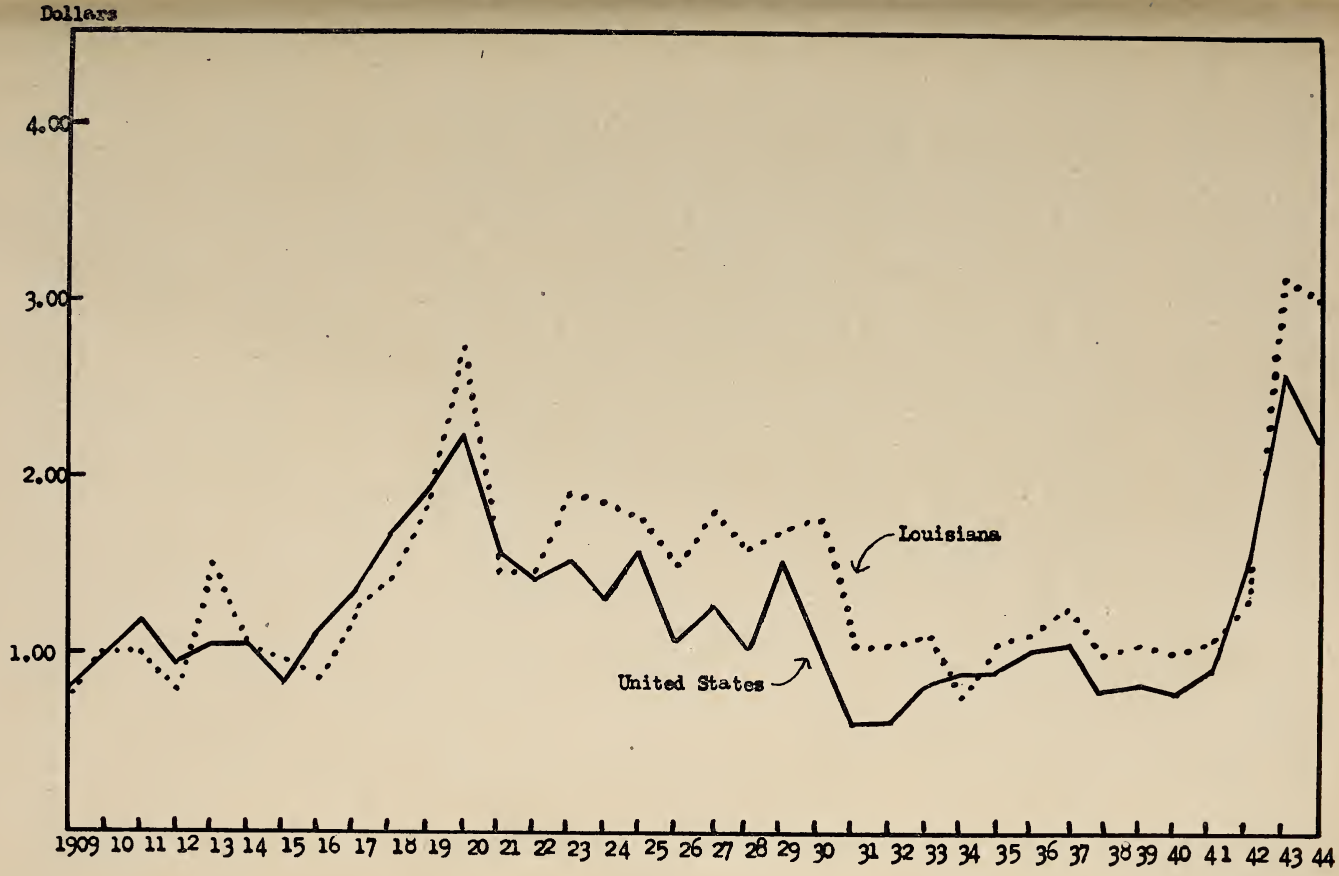


FIGURE 6.—The Louisiana farm price of peaches as a rule is higher than the average farm price for the United States.
SOURCE: "Agricultural Statistics," "Agricultural Prices," and Department of Agricultural Economics, Agricultural Experiment Station, Mimeograph Circular No. 49.

MARKETING PRACTICES

Very little information is available on the marketing of peaches in Louisiana. Commercial production is small and scattered and for this reason specific marketing channels have not been developed. Any program aimed at development of the peach enterprise in Louisiana must consider the available markets and the methods by which the increased production will be marketed.

Information in regard to prevailing marketing practices, particularly in regard to the usual marketing period, packaging and grading, and methods of sale was obtained from the commercial growers cooperating in this study. The information applies mainly to the 1944 crop year, and it is recognized that marketing methods were influenced by high wartime demands and wartime conditions—thus varying considerably from conditions that would be expected in normal times.

Usual Marketing Dates: There is a wide range in the marketing period. It is estimated that in 1944 about 15 percent of the crop was marketed from May 1 to June 15, 50 percent from June 15 to July 15, 30 percent from July 15 to August 15, and 5 percent from August 15 to October 15. The principal variety is the Elberta, but there were a number of other varieties that ripened anywhere from early in May through the middle of October. With greater specialization in peach production it is expected that a higher proportion of the crop will be Elbertas because of their superiority under Louisiana conditions. Concentration on the production of Elbertas will tend to increase the difficulties in marketing, however, and increase the need for better marketing of the crop.

Packaging and Grading: Only one of the producers included in the group studied, graded and packed peaches in a special pack. This was done because of a contract for the sale of the entire crop to one buyer with a special demand. All other producers sold on a semi-field run basis. As a rule the producer did not furnish containers, these being furnished by the buyer.

Peaches were generally graded by hand as to size, firmness, and quality when picked from the trees. Culls were eliminated in the field.

Sales: Most peaches from the orchards studied were sold at the farm to truckers who were also buying watermelons, cantaloupes, peaches, and apples. When not sold at the farm, they were sold at nearby points, such as Ruston, Monroe, Homer, or Shreveport.

Peaches were frequently sold along with watermelons. Producers who follow the practice of hauling watermelons to certain areas of the state often carry a mixed load including peaches. Considerable marketing of this sort is practiced by farmers who market their produce east of Monroe, Alexandria, and points South, and in Shreveport. It was impossible to obtain reliable information from the producers as to the exact destination because they did not know.

THE INDEX OF THE PRICE OF PEACHES IN LOUISIANA AND THE INDEX OF WHOLESALE PRICES OF ALL COMMODITIES IN THE UNITED STATES, 1909-44.

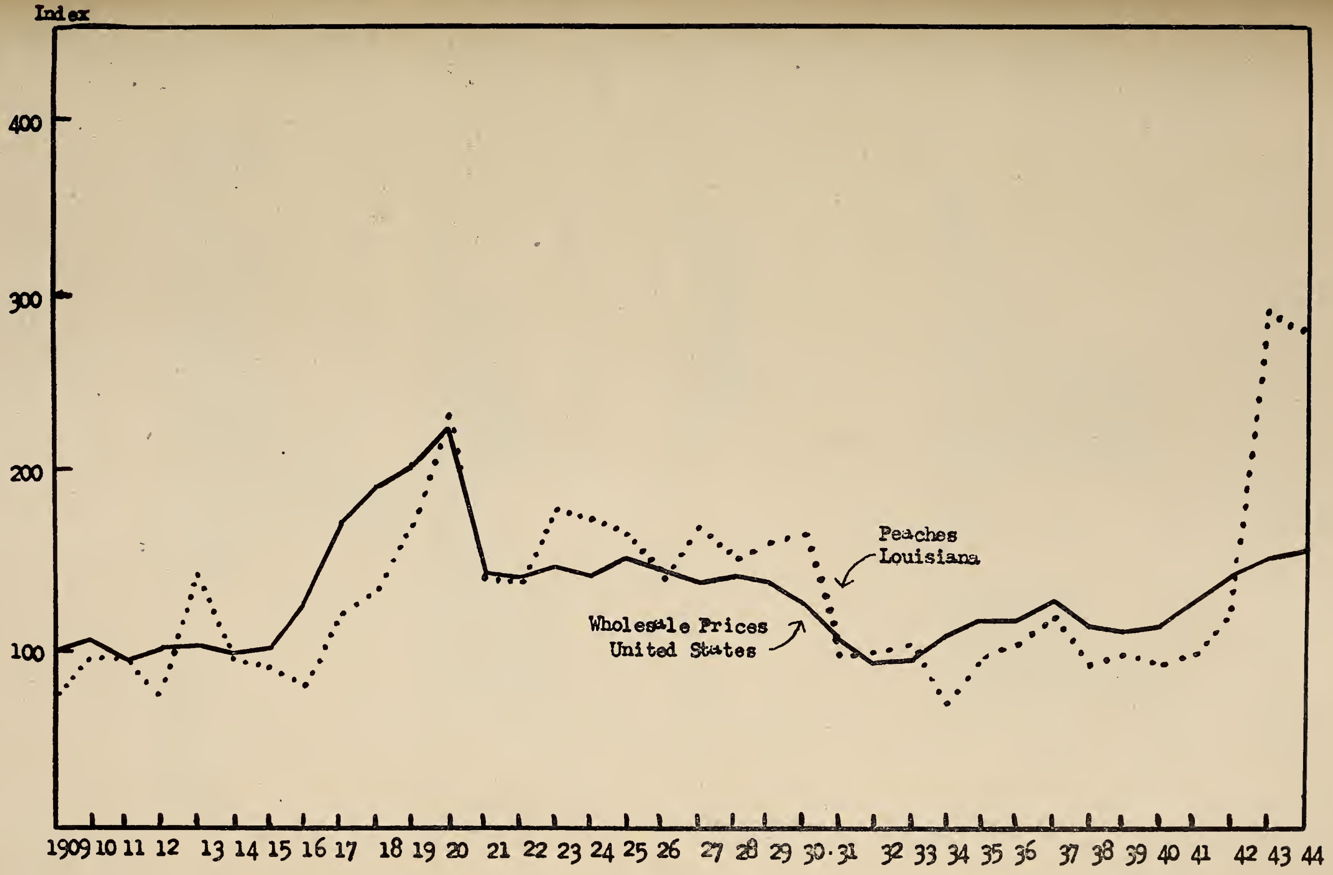


FIGURE 7.—The index of the price of peaches in Louisiana follows closely the movement of the general price level.
SOURCE: Department of Agricultural Economics, Agricultural Experiment Station Mimeographed Circular No. 49, and "Farm Economics," Cornell University.

THE PLACE OF THE PEACH ENTERPRISE IN FARMING SYSTEMS

It is becoming increasingly apparent that more diversification is desirable in the organization of farms in the hill sections of Louisiana. The cotton enterprise has declined in importance during the past decade and in many cases suitable alternatives have not been developed to any great extent. An expansion of the peach enterprise appears to offer promising possibilities as a supplementary source of farm income on many farms in these areas.

The Utilization of Farm Resources: With the present cropping system on most farms in the North Louisiana Upland Cotton Area, full utilization of the farm resources is not being achieved. Considerable cropland is lying idle that is ideal for the production of peaches.

Very little additional equipment would be required for a moderate expansion of the enterprise. Spraying equipment is the only additional item of equipment necessary. In the past most spraying has been done with a barrel spray. It should be pointed out that a barrel spray will not do the job as effectively as it should be done to be consistent with desirable orchard management. Some type of power spray is recommended regardless of the size of the orchard even though it is necessary to own this special equipment cooperatively with other producers. Where orchards are developed, it is probable that more complete utilization will be made of farm power and equipment. This is desirable, because per acre and per hour costs of performing operations would be reduced with fuller utilization of the farm machinery.

Successful peach production is highly specialized, but the managerial capacity of many farmers in the area is sufficient to handle the enterprise on a commercial scale.

The production of peaches will provide increased employment opportunities because it is a labor intensive crop—even more so than cotton. Approximately one-third more labor is required to produce and harvest an acre of peaches than is required for cotton.

The Distribution of Labor: Labor required in peach production is well distributed throughout the year and fits well into the usual cropping system, figure 8. Considerable labor is required during the winter and early spring months when there is little other farm work to be done. During May and June, however, there is some conflict in labor requirements with the other crops—cotton, corn, and sweet potatoes. The peak requirements in peach production occur in July after most of the other crops have been laid by. There is little or no conflict in labor requirements for peach production with other crops during the general harvesting season in September and October. In conclusion it appears that the production of peaches affords an opportunity to obtain better labor distribution throughout the year and competes seriously for labor only during the months of May and June. The trend toward mechanization will tend to reduce the seriousness of this competition for labor as recent

THE USUAL DISTRIBUTION AND THE HOURS OF MAN LABOR REQUIRED TO GROW AND HARVEST 10 ACRES EACH OF PEACHES, COTTON, CORN, AND SWEET POTATOES, NORTH LOUISIANA UPLAND COTTON AREA.

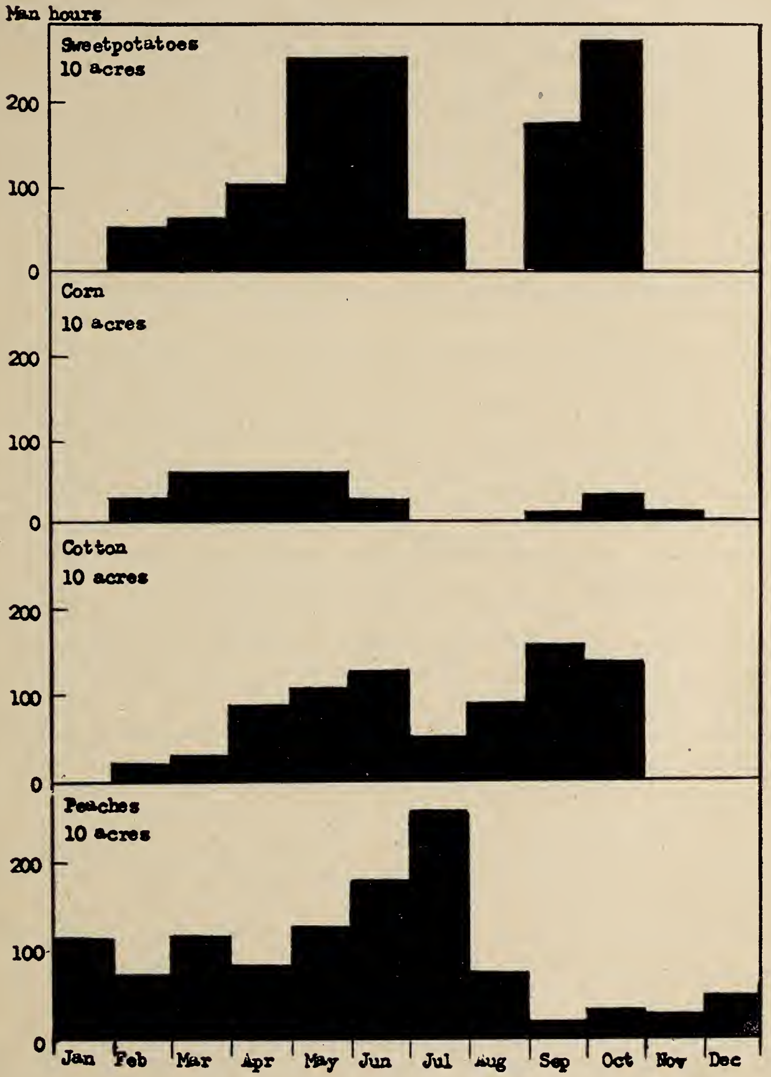


FIGURE 8. It requires approximately one-third more man labor to produce an acre of peaches than cotton. Peaches require less labor than sweet potatoes, however. There is some competition between peaches and other crops during May and June, but this competition is not serious. The peak labor period for peaches is during the harvesting season in late June and July after most farm crops are laid by. The labor requirements for peaches are well distributed throughout the year.

studies show the greatest reduction in man labor requirements are achieved in the pre-harvest operations for most crops.

Peaches as a Cash Crop Alternative: On the basis of the results of this analysis it is apparent that the peach enterprise has been profitable in the past. When the results on net enterprise returns per acre and per hour of man labor are compared with the results of other farm management research in the same general area, it is evident that when the orchards are handled efficiently, peach production has favorable possibilities as a major cash crop.[6] The profitableness of an expanded peach enterprise in Louisiana, however, depends greatly upon the development of a marketing organization which will effectively market the commercial production.

SUMMARY

This report describes the peach enterprise as it is found on North Louisiana farms and appraises the economic possibilities of expanding the production of peaches. The declining importance of cotton as a major cash crop increases the need for developing new enterprises that are adapted to local conditions in order to provide fuller employment of human and physical resources and to increase the farm income.

The production of peaches is concentrated in the northern hill areas of Louisiana, mainly the North Louisiana Upland Cotton Area and the areas bordering it. Peaches have been grown in the sandy-hill sections for many years but the development of commercial production has been slow. In recent years more farmers have paid close attention to the enterprise and peach production has assumed a prominent place along with other crops in the organization of some hill farms. Generally the commercial producers have been efficient in performing desirable management practices, but those producing peaches in small home orchards have not handled their orchards well.

Commercial production is still small in relation to the total production. Over one-half or about 55 percent of the total farm value of peaches in Louisiana is consumed at home on the farm, leaving only about 45 percent for cash sales.

It requires about 4 years to develop a peach orchard. Some trees bear a small crop in the third year but most producers do not expect a crop until the fourth season.

The cost of developing a commercial orchard is important and a knowledge of development costs enables prospective producers to appraise the production of peaches as an alternative to other crops. The cost of development varied for different power systems. On farms using tractors the development cost at 1944 prices for 3 years was $102.39. With prices in a period such as 1935-39 the cost of developing an acre was

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[6] For further information on the relative returns from the different crops the reader is referred to the following unpublished manuscripts: "An Economic Study of the Sweet Potato Enterprise in the North Louisiana Upland Cotton Area in 1943" by Leo J. Fenske and J. Norman Efferson; and "Mechanization on Hill Farms in North Louisiana" by Leo J. Fenske and Frank D. Barlow, Jr.

$75.68. Where mules were the principal sources of power development cost for 3 years at 1944 prices amounted to $87.93 an acre. For the period 1935-39 the cost of development was only $60.19 on these farms.

Development costs were much higher in 1944 than in 1935-39, mainly because of higher labor and power costs. It cost a little over one-third more to establish an acre of peaches in 1944 on tractor farms than in 1935-39 and about 46 percent more on mule operated farms.

On the basis of the experience of producers now growing peaches in the areas studied, approximately 90 hours of man labor are required to develop an acre of peaches on tractor operated farms. Approximately 18.6 hours of tractor work, and 23.8 hours of mule work were required on these farms. Where mules were the principal source of power 104.6 man hours were required for development, 1.0 tractor hour, and 69.5 mule hours.

At 1944 prices and yields the cost of producing a bushel of peaches, exclusive of containers, was $0.76 on tractor farms, and $0.83 on mule farms. At 1935-39 prices and normal yields the cost of producing a bushel of peaches was $0.51 on tractor farms and $0.54 on mule farms.

Net enterprise returns were extremely favorable in 1944 because of the combination of high per acre yields and record breaking prices.

The average returns per acre in 1944 for orchards in full production on tractor farms was $196.56. On mule farms the per acre return was $150.54. Net returns average much lower in periods of normal prices and normal yields. With prices as those in 1935-39 and normal yields the per acre returns are estimated to be $58.68 on tractor operated farms and $44.08 on mule operated farms.

The production of peaches is an intensive labor crop requiring more man labor to grow and harvest an acre of peaches in production than for cotton. On tractor farms about 115 man hours are required and on mule farms about 106 man hours are required. Approximately 7.3 tractor hours and 33.4 mule hours are required per acre on tractor farms; and 1.7 tractor hours and 45 mule hours are required on mule operated farms.

The differences in the operation of commercial orchards on tractor operated farms and mule operated farms are not limited entirely to the type of power used. As a rule those farmers that were using tractor power extensively were following more closely the recommended orchard practices, such as cultivation, fertilization, winter cover crops, etc. Better orchard management on the tractor farms resulted in higher per acre costs, but lower per bushel costs because of higher yields.

Average yields of peaches in Louisiana are lower than for the country as a whole. The yield per tree has been increasing since 1909, but the number of bearing trees decreased considerably from 1909 to 1934—since then the number of bearing trees has been increasing.

The production of peaches in recent years is below the production reported in the period 1909-19. Annual production information is helpful in determining the occurence of poor production years. It appears that farmers in Louisiana may normally expect about one poor peach crop out of five.

The price of peaches in Louisiana follows a similar course to that of the general price level. With but few exceptions the price of peaches in Louisiana has averaged higher than for the country as a whole. There is only one year on record in which the price of peaches in Louisiana has averaged less than one dollar a bushel and that was in 1934 when economic activity was low and the production was above average.

The marketing system for peaches is unorganized throughout most of the peach producing sections and producers in the past have disposed of their crop locally as best they could. Commercial production is small and scattered and for this reason the development of market channels has been neglected.

There is a wide range in marketing dates, but the bulk of the Louisiana crop is marketed during the first part of July when the Elbertas are in season. Elbertas appear to be superior to most other varieties and any growth in the enterprise in Louisiana will accentuate the need for developing a marketing system in order to dispose of production in the peak period.

In the past there has been no consistent method of grading, packaging or selling on the part of producers. If the enterprise is developed in Louisiana, more emphasis must be placed upon each of these phases of marketing—otherwise, the enterprise may fail completely.

There is a place for the peach enterprise on many farms in the hill areas of North Louisiana. The production of peaches is a highly specialized job and should not be attempted unless the operator is willing to devote considerable time and effort to the enterprise.

The development of the enterprise in Louisiana affords an opportunity for many farmers to obtain a better utilization of the farm resources. Land and equipment that is not now fully utilized may be put to a productive use. Peach production is an intensive labor crop, but much of the work in orchards can be done when other farm work is not pressing—thus much employment is provided in the "slack" season. Though managerial requirements are exacting there appears to be ample managerial capacity in the area to develop the enterprise commercially.

The author expresses his appreciation to Professor B. M. Gile who criticized the manuscript and offered many helpful suggestions. Acknowledgment is made to Mr. Dawson M. Johns and Mr. Lynn Hathorne of the North Louisiana Experiment Station, and to Dr. Julian C. Miller, Head of Horticultural Research in Louisiana, who read the manuscript and provided valuable assistance in the interpretation of the data.

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TRACTORS ON UPLAND FARMS IN NORTH LOUISIANA

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TRACTORS ON UPLAND FARMS IN NORTH LOUISIANA

By

LEO J. FENSKE AND FRANK D. BARLOW, JR.[1]

INTRODUCTION

Farm tractors have not been used to any extent in the North Louisiana Upland Cotton Area until quite recently. However, the current shortage of farm labor has caused many farmers to turn to tractors as a source of power, and by 1944, there were 661 tractors on farms in this area. Probably many more would have been purchased if they had been available. Table 1 shows tractor numbers by parishes for selected years.

TABLE 1. TRACTORS ON FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944 WITH COMPARISONS

Parish	*1925*[1]	*1930*[1]	*1940*[1]	*1942*[2]	*1944*[2]
Bienville	3	7	21	60	82
Claiborne	9	12	37	50	78
De Soto	9	34	73	131	165
Jackson	1	8	11	11	22
Lincoln	9	8	28	36	54
Sabine	5	7	11	30	49
Union	3	10	37	49	91
Webster	2	18	70	107	120
TOTAL	41	104	288	474	661

[1] Federal Census data.
[2] Triple A data.

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[1] Bureau of Agricultural Economics and Louisiana Agricultural Experiment Station, respectively.

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Appreciation is expressed to W. P. Knight, County Agent in Bienville Parish; E. E. James, County Agent in Claiborne Parish; and J. A. Shealy, County Agent in Lincoln Parish, for their valuable assistance in carrying out the survey in their respective parishes; and finally the authors are especially indebted to the 62 farmers and the local machinery dealers in the area who furnished the basic information for **this report.**

It is anticipated that the trend toward more complete mechanization of farms in the hilly areas will continue during the postwar years, and that numerous questions will be raised by farmers over the cost of operating tractors and the accomplishments of tractors as compared with mules as a source of power. Since a number of farmers in the area have had considerable experience with tractors, it was felt that they could make a valuable contribution with respect to what can be expected of tractors in the hilly areas; consequently a farm survey was undertaken in Bienville, Claiborne, and Lincoln parishes in the spring of 1945. Sixty-two farmers have supplied the data on which this report is based.

The purposes of this bulletin are (1) to determine the cost of operating tractors and the cost of keeping workstock on hill farms, and (2) to compare the labor and power required per acre and production costs per acre for the major crops grown in the area when produced with tractors and when produced with mules. In addition to answering some of the immediate questions that might be raised concerning tractors, the basic data presented in this bulletin will be useful in analyzing farm readjustment possibilities for the North Louisiana Upland Cotton Area.

DESCRIPTION OF AREA

The North Louisiana Upland Cotton Area as outlined in Figure 1 contains approximately 20 percent of the total farm land in the State.[2] Most of the area consists of sandy, coastal plains soils which in many instances are low in fertility. Heavy applications of nitrogen and mixed fertilizers are usually necessary to hold crop yields at a profitable level. In general a rolling topography prevails, and soil erosion becomes a problem on the steeper slopes. Substantial acreages of woodland remain both on farms and on land not in farms.

Although some large farms are found in the area, the holdings are usually of a size that can be operated with family labor, or with one or two cropper families in addition to that supplied by the operator's family. The average farm size in 1939 was 110 acres with 46 acres of cropland.[3]

The agricultural economy of the region is centered around cotton, although in recent years some shifts have taken place toward the production of feed crops and livestock. Minor cash crops in the area are sweetpotatoes, peanuts, watermelons, peaches, tomatoes, and other truck crops. Corn is the main feed grain produced although oats are increasing in importance.

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[2] 1940 Census.

[3] Census data adjusted so as to exclude cropper units.

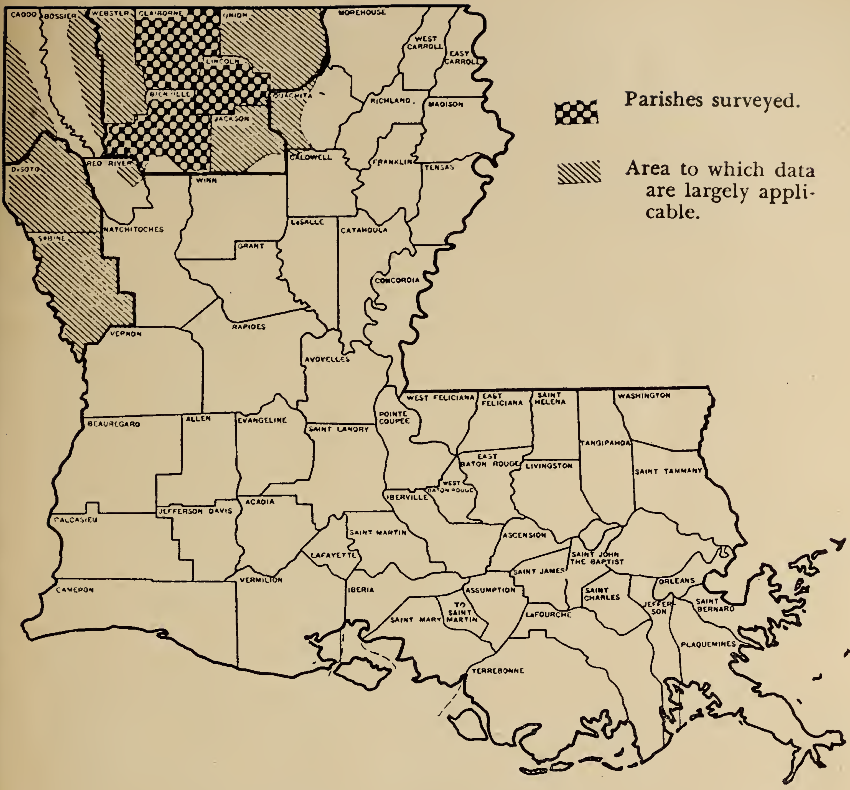

FIGURE 1. Location of North Louisiana Upland Cotton Area.

At the present time much idle cropland exists on the active farm units, and many small farms have been abandoned for the duration of the war. Attractive opportunities for employment elsewhere have caused labor to migrate from this area.

ORGANIZATION OF TRACTOR FARMS

Data on 1944 farming operations with special emphasis on tractor costs and use were obtained from 62 farmers in the North Louisiana Upland Cotton Area, who had one year or more experience with tractors. Those with less than one year of experience were excluded in order to insure greater accuracy in the information. Because of the selectivity involved, the sample cannot be considered as representative of all farms in the area, but it does present a good cross-section of the tractor farms. About one-third of the tractor operators in the three parishes were interviewed.

In order to present information which will be the most useful to typical farmers in the area, the multiple-tractor farms were excluded from the data shown in Table 2. The 56 farms operated with one tractor and workstock were divided into size groups based on acres in crops. It should be noted that 16 farms fell into the size group of 75 acres or less in crops, which indicates that some of the smaller operators are purchasing tractors. Nineteen farms contained 76 to 150 acres in crops, while 21 had 151 acres or more in crops. All the farms operated with one-tractor and workstock averaged 419 acres in size with 136 acres in crops in 1944.[4]

TABLE 2. Land Use, Livestock Numbers, and Labor and Power Data on 56 Farms in the North Louisiana Upland Cotton Area, 1944

Item	*All farms*	*Size group*[1]		
		75 acres or less	*76-150 acres*	*151 acres and over*
Number of farms	56	16	19	21
Acres per farm:				
Cotton	48.6	14.5	33.4	88.4
Corn	39.7	20.7	35.4	58.1
Small grains and hay	33.7	12.9	23.4	58.9
Truck and orchard	4.8	4.1	8.0	2.6
All other crops	8.7	7.2	5.9	12.4
Total tilled	135.5	59.4	106.1	220.4
Idle cropland	47.2	26.3	37.8	71.7
Permanent pasture (open)	72.7	41.1	34.8	131.1
Woodland and other	163.2	70.9	87.2	302.3
Total	418.6	197.7	265.9	725.5
Livestock numbers per farm:				
Workstock	4.9	1.8	3.5	8.5
Other horses	1.6	1.2	0.6	2.8
Milk cows	9.5	3.7	8.2	15.1
All other cattle	36.0	22.9	19.9	60.5
Brood sows	1.6	1.1	1.5	2.1
Labor and power:				
Families per farm[2]	3.6	1.4	2.8	6.1
Acres in crops per family	37.6	42.4	37.9	36.1
Tractors per farm	1.0	1.0	1.0	1.0
Average drawbar H.P. rating	17.27	15.90	17.26	18.37
Tractor days per year on farm	88	63	73	120
Tractor days per year off farm	14	13	11	18
Workstock days per farm	385	87	249	735

[1] Based on acres in crops.

[2] Includes operator's family.

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[4] Five large farms operated with 2 or more tractors each were not included in this section. These farms averaged 1,048 acres in size with 411 acres in crops.

Cotton and corn were the chief crops produced, with cotton averaging 36 percent of the tilled cropland; and corn, 29 percent. Some variation in the relative importance of these two crops can be noted between the different size groups. Small grains and hay were more important on the farms in the group containing 151 acres and over than on farms in the other two groups. The truck crop and orchard acreage averaged highest on farms in the middle group.

All one-tractor farms averaged 4.9 head of workstock, 9.5 milk cows, 36.0 other cattle, and 1.6 brood sows per farm during 1944. The numbers of livestock increased with farm size as shown in Table 2.

The permanent labor force on these farms consisted of 3.6 families per farm, including the operator's family. Each family handled about 38 acres of crops. More than half of the farms in the small size group were operated without the aid of cropper labor, while the medium group operators used from 1 to 2 cropper families per farm. All farms with more than 150 acres in crops averaged 5 additional families per farm beside the operator's family.

The size of tractor increased as farm size increased, as did also the number of days of tractor use (Table 2). On an average the tractors were used 88 days per year on the farm, and 14 days per year off the farm in doing custom work for neighbors.

MACHINERY INVENTORIES

The inventory value of the farm machinery except motor vehicles and trailers averaged $2,365 per farm for all one-tractor farms. In 1944 this amounted to $17.45 per acre in crops. The tractor investment com-

TABLE 3. AVERAGE INVESTMENT IN TRACTORS, TRACTOR EQUIPMENT, AND MULE EQUIPMENT PER FARM AND PER CROP ACRE, 56 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944[1]

Item	All farms		Size group[2]					
			75 acres or less		*76-150 acres*		*151 acres and over*	
	Per farm	*Per acre in crops*	*Per farm*	*Per acre in crops*	*Per farm*	*Per acre in crops*	*Per farm*	*Per acre in crops*
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Tractors	899	6.63	818	13.77	901	8.49	958	4.35
Tractor equipment ...	780	5.76	560	9.43	750	7.07	974	4.42
Combines and hay balers....	171	1.26	106	1.78	56	.53	324	1.47
Mule drawn equipment ...	515	3.80	139	2.34	426	4.01	883	4.00
TOTAL.......	2,365	17.45	1,623	27.32	2,133	20.10	3,139	14.24

[1] Investment on a new cost basis.
[2] Based on acres in crops.

prised about 40 percent of the total; tractor equipment another 40 percent; and mule-drawn equipment, 20 percent. Table 3 presents investment data for the farms surveyed, classified by size.

In general the total investment in machinery varied directly with size of farm, while the investment per acre in crops varied inversely. The small farms averaged $27.32 per acre in crops in total machinery investment as compared with $20.10 and $14.24, respectively, for the medium and large size groups.

COST OF OPERATING FARM MACHINERY

The expense for farm machinery upkeep is usually a substantial item on most farms. In this survey, data were gathered on the cost of operating farm machinery and the results are summarized in Table 4. The repairs and upkeep costs were estimated by the farmers, as was also the estimated life of the individual machines. Depreciation was calculated on a straight-line basis with no allowance for salvage value. Interest was charged at 5 percent of the average value of the investment over the lifetime of the machine. Repairs and upkeep are in the nature of cash expenses while depreciation and interest are generally non-cash charges. However, the last two items must be met in the long-run if the farmer is to remain in business.

The total annual expenses for tractor machinery on these farms averaged $160 per farm, consisting of $73 for repairs, $67 for depreciation,

TABLE 4. AVERAGE COST OF OPERATING TRACTOR DRAWN AND MULE DRAWN EQUIPMENT ON 56 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item			*Size group*[1]					
	All farms		*75 acres or less*		*76-150 acres*		*151 acres and over*	
	Tractor equip.[2]	*Mule equip.*	*Tractor equip.*[2]	*Mule equip.*	*Tractor equip.*[2]	*Mule equip.*	*Tractor equip.*[2]	*Mule equip.*
	Dol.	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Annual equipment charges per farm:								
Repairs and upkeep	73	70	52	18	61	47	101	131
Depreciation	67	45	44	9	58	35	91	81
Interest	20	13	14	3	19	11	24	22
TOTAL	160	128	110	30	138	93	216	234
Average Cost:								
Per acre in crops..	1.18	0.94	1.85	0.51	1.30	0.88	0.98	1.06
Per tractor hour..	.156	——	.145	——	.164	——	.157	——
Per workstock hour	—	.033	——	.034	——	.037	——	.032

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[1] Based on acres in crops.
[2] Excludes tractors, combines, peanut pickers, and hay balers.

and $20 for interest charges. The average expenses amounted to $1.18 per acre in crops, and $0.156 per hour of tractor use. Mule equipment expenses averaged $128 per farm, $0.94 per acre in crops, and $0.033 per hour of workstock use. Comparisons as between size groups can be made in Table 4. Additional information on expenses per individual machine can be found in the appendix.

The foregoing analysis does not include the expense of operating combines and hay balers, because these two implements were not common to all farms. Data are presented separately in the following paragraphs.

Combines: The oats crop is still relatively unimportant in this area but acreages are increasing, especially on the larger farms. A large part of the crop is cut for hay because grain harvesting equipment is lacking. Nine small combines ranging in width from 42 to 60 inches were included in the survey. Cost data for these are presented in Table 5.

TABLE 5. AVERAGE COST OF OPERATING 9 SMALL COMBINES IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item	*Cost per year*	*Cost per acre*[1]	*Cost per hour*[2]
	Dol.	*Dol.*	*Dol.*
Repairs and upkeep[3]	38.83	0.56	0.58
Depreciation[4]	58.60	.84	.88
Interest[5]	14.65	.21	.22
TOTAL	112.08	1.61	1.68

[1] Average acreage harvested in 1944 per combine, 69.6 acres.
[2] Based on average rate of 1.04 acres per hour.
[3] Average of farmers' estimates.
[4] Average purchase price was $586 and the estimated useful life was 10 years.
[5] Interest charged at 5 percent of one-half of average purchase price.

Combine operating costs per machine averaged $112.08 per year or $1.61 per acre. Repairs and upkeep averaged $38.83; depreciation, $58.60; and interest, $14.65. Power costs are not included. The costs on a per acre basis can be reduced by harvesting a larger acreage in a season. In 1944 about 70 acres per machine were combined, including custom work.

Stationary hay balers: A need for additional modern haying equipment also exists in the North Louisiana Upland Cotton Area. Fifteen stationary hay balers were used on the farms studied. These averaged baling 130 acres per machine in 1944, including custom work. Operating cost data for stationary balers are shown in Table 6.

The annual charges per baler, excluding power costs, averaged $59.42. Depreciation charges were the largest item. Based on 1944 use baler costs averaged 45 cents per acre or 55 cents per ton of hay baled.

TABLE 6. AVERAGE COST OF OPERATING 15 STATIONARY HAY BALERS IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item	*Cost per year*[1]	*Cost per acre*[2]	*Cost per ton*[3]
	Dol.	*Dol.*	*Dol.*
Repairs and upkeep	12.20	0.09	0.11
Depreciation	34.09	.26	.32
Interest	13.13	.10	.12
TOTAL	59.42	.45	.55

[1] Cost per year based on farmers' estimates for repairs and upkeep, an average purchase price of $525 depreciated over 15.4 years, and an interest charge of 5 percent of one-half the purchase price. Does not include the cost of power used.

[2] Average acres baled in 1944 per machine, 130; average yield per acre, 0.83 tons.

[3] Average tons baled in 1944 per machine, 108.

FARM POWER COSTS

This section presents data on tractor and mule costs for 1944 based on all farms included in the survey. The costs presented are averages and should be interpreted as such. Although considerable variation occurs between individual cases because of the nature of work, extent of use, care in operating the tractor, and many other factors, the data given here can be useful in getting the over-all situation in view.

COST OF OPERATING TRACTORS

The tractors in use on the farms surveyed were relatively new as indicated by the fact that 60 percent of them consisted of 1941 or later models. Thirty percent were 1938, 1939, or 1940 models, leaving only 10 percent older than this. Rubber tired tractors predominated with only two out of the entire group mounted on steel wheels.

Estimates were secured from the farmers on fuel, oil, and grease consumption and costs, repair costs, amount of time spent in servicing the tractor, days of use, and other data pertinent to tractor upkeep and use. Dealers in the area were interviewed to check and verify certain cost items and estimates. These data have been summarized and are shown on a 10-hour day basis in Table 7.

Two types of costs are distinguished; namely, cash and overhead costs. The cash costs consist of fuel, lubricants, repairs, and service labor. In actual practice service labor is not always a cash expense because many operators drive and service their own tractors. All tractors averaged $2.98 cash outlay per 10-hour day of use with fuel comprising about 57 percent of this amount. The smaller tractors averaged less than the larger tractors in cash expenses per 10-hour day.

The overhead costs consisting of depreciation and interest averaged $1.24 per 10-hour day of use. Depreciation charges were based upon the farmers' estimates of the length of life of the tractors, while interest was calculated at 5 percent on one-half of the average purchase price. In the long-run these two charges must be met if tractors are to be replaced when worn out. In this study no charge has been made for shelter because of the difficulty in allocating shelter charges to a single machine.

TABLE 7. AVERAGE COST OF OPERATING ONE- AND TWO-PLOW TRACTORS PER 10-HOUR DAY, NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item	*All Tractors*	*One-plow tractors*	*Two-plow tractors (Less 17 H. P.)*	*Two-plow tractors (17 H. P. and over)*
Number of tractors	71	20	33	18
	Dollars	*Dollars*	*Dollars*	*Dollars*
Cash costs:[1]				
Fuel (gasoline or fuel oil)	1.71	1.38	1.80	1.90
Grease, oil and oil filters	.42	.42	.34	.55
Repairs	.59	.61	.59	.58
Service labor	.26	.26	.25	.28
Total cash cost	2.98	2.67	2.98	3.31
Overhead costs:				
Depreciation	.98	.95	.86	1.22
Interest	.26	.26	.21	.34
Total overhead cost[2]	1.24	1.21	1.07	1.56
Total cost per 10-hour day	4.22	3.88	4.05	4.87
Total cost per hour	.42	.39	.41	.49
Average purchase price	$897	$733	$850	$1,164
Aver. drawbar H.P. rating[3]	17.24	14.94	16.13	21.82
Hours used per year:				
On farm	813	735	910	722
Custom	210	88	241	291
Total	1,023	823	1,151	1,013
Belt work	61	52	68	58
Percent custom work	20.5	10.7	20.9	28.7
Percent belt work	6.0	6.3	5.9	5.7

[1] Gasoline, $0.185 per gallon; fuel oil, $0.08 per gallon; lubricating oil, $0.20 per quart; grease, $0.16 per pound; filters, $0.65 to $1.25 each; service labor, $0.30 per hour; and repairs as estimated by the farmers interviewed.

[2] Does not include a charge for shelter.

[3] Test F, Nebraska Tractor Tests.

Total operating costs per 10-hour day averaged $4.22 for all tractors, $3.88 for the one-plow tractors, $4.05 for the two-plow tractors of less than 17 horsepower, and $4.87 for the two-plow tractors of 17 horsepower or over.

Operating costs run higher when the tractor is engaged in heavy work, such as breaking or discing, than when used for light work, such as planting, cultivating, or mowing hay. Table 8 shows that on an average from 20 to 30 percent more fuel was consumed when tractors were used at heavy drawbar work than at light drawbar or belt work. No appreciable difference was reported in oil consumption for the different kinds of work.

TABLE 8. AVERAGE FUEL, OIL, AND GREASE USED PER 10-HOUR DAY BY TRACTORS FOR HEAVY AND LIGHT DRAWBAR WORK AND BELT WORK, NORTH LOUISIANA UPLAND COTTON AREA, 1944

Kind of tractor and nature of work	*Average per 10-hour day*					
	Fuel combination			*Gasoline only*	*Oil*	*Grease*
	Gasoline	*Fuel oil*	*Total*			
	Gals.	*Gals.*	*Gals.*	*Gals.*	*Qt.*	*Lb.*
One-plow tractors:						
Heavy drawbar[1]	1.5	10.5	12.0	10.3	1.3[4]	0.2[4]
Light drawbar[2]	1.2	8.1	9.3	7.4		
Belt	1.3	8.2	9.5	6.7		
Two-plow tractors (Less 17 H. P.):[3]						
Heavy drawbar[1]	—	—	—	11.5	0.8[4]	0.2[4]
Light drawbar[2]	—	—	—	8.8		
Belt	—	—	—	9.1		
Two-plow tractors (17 H. P. and over):						
Heavy drawbar[1]	1.8	15.3	17.1	18.5	1.9[4]	0.4[4]
Light drawbar[2]	1.6	12.6	14.2	15.0		
Belt	1.5	13.2	14.7	13.3		

[1] Flat breaking, discing, bedding, etc.

[2] Planting, cultivating, mowing, etc.

[3] This group used gasoline almost exclusively for fuel.

[4] Average for all operations.

Gasoline was the most popular tractor fuel used in this area. Sixty percent of the tractors were operated on gasoline, and the balance on fuel oil with gasoline used only for starting.

Another factor influencing tractor costs is the extent of use in a given season. Cash costs per day remain fairly constant with a slight tendency to increase with added use because of greater expenses for upkeep, while overhead charges per day decline with use. Table 9 shows the relationship of days used and cost of operation for 49 two-plow tractors. The one-plow tractors are not included in this analysis because they were not evenly distributed among the classes set up.

The 12 tractors which were operated 80 days or less per year averaged 49 cents per hour in total operating costs, while the 26 tractors which were operated 101 days and over per year averaged 41 cents per hour in total costs. Farmers planning to replace mules with tractors should take this into account. However, on small farms additional use can be made of the tractor by engaging in custom work. Custom work averaged 20.5 percent of the total hours of use in 1944 for all tractors studied (Table 7).

TABLE 9. Relationship of Days Used and the Cost of Operation for 49 Two-Plow Tractors, North Louisiana Upland Cotton Area, 1944[1]

Days of use per year	Number of tractors	Average days used	Ave. cost per 10-hour day			Cost per hour
			Cash	Over-head	Total	
		No.	Dol.	Dol.	Dol.	Dol.
80 or less	12	65	3.12	1.81	4.93	0.49
81-100	11	90	3.13	1.32	4.45	.45
101 and over	26	148	3.16	.92	4.08	.41
All tractors	49	115	3.15	1.23	4.38	.44

[1] Average drawbar H.P. rating, 18.42.

Cost of Keeping Workstock

Mules and horses still continued to be an important source of power on the farms studied. Tractors carried the bulk of the land preparation load, while workstock were used chiefly for cultivating,[5] hauling crops, haying, woods work, and other miscellaneous jobs. Tractors have been used only a relatively short time, and mules have not been reduced to a minimum as yet. The survey data reveal that an average of three mules have been disposed of for each tractor purchased. More can be sold when adjustments in cropping systems and labor organizations have been completed. Some of the farmers reported that the present low demand for mules in the area has served as a deterrent to the selling off of surplus workstock.

The cost of maintaining workstock runs into a substantial item of expense in a year. Calculations based upon prices paid as reported by the farmers interviewed indicate that the cost of keeping workstock averaged $161.12 per head in 1944. Feed prices were relatively high, and feed including a charge for pasture amounted to 78 percent of the total charges. Although in many sections these costs are largely non-cash in nature, in a feed deficit area such as the one studied, farmers often have to purchase feeds. Table 10 shows the average cost of keeping workstock per head in 1944 for all head, and for groups according to the number of days worked.

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[5] One-half of the farmers reported using tractors for cultivating cotton and corn.

TABLE 10. Average Cost of Keeping Workstock Per Head, North Louisiana Upland Cotton Area, 1944[1]

Item	*All head*		*Days worked per year*					
			1-59		*60-89*		*90 and over*	
	Amount	*Cost*	*Amount*	*Cost*	*Amount*	*Cost*	*Amount*	*Cost*
Feed:								
Corn, bu.	52.8	$ 76.56	41.2	$ 59.74	50.5	$ 73.72	67.5	$ 97.88
Oats, bu.	1.2	1.20	3.8	3.80	—	——	0.7	.70
Legume hay, tons	1.3	39.00	1.2	36.00	1.3	39.00	1.3	39.00
Non-legume, hay tons	0.2	4.40	0.2	4.40	0.3	6.60	—	——
Salt, lbs.	27.1	.35	27.8	.36	24.9	.32	30.8	.40
Pasture, mo.	4.5	4.50	5.2	5.20	4.7	4.70	3.4	3.40
Total feed costs	xx	$126.01	xx	$109.50	xx	$124.34	xx	$141.38
Other costs:								
Depreciation	—	$ 14.35	—	$ 13.69	—	$ 14.08	—	$ 15.18
Interest	—	4.49	—	4.18	—	4.23	—	5.09
Chore labor, hrs.	49	9.80	48	9.60	54	10.80	42	8.40
Harness	—	5.77	—	5.23	—	6.19	—	5.85
Miscellaneous[2]	—	.70	—	.90	—	.60	—	.60
Total other costs	xx	$ 35.11	xx	$ 33.60	xx	$ 35.90	xx	$ 35.12
Total all costs	—	$161.12	—	$143.10	—	$160.24	—	$176.50
Hours worked, avg.	—	723	—	408	—	719	—	1,024
Cost per hr. worked	—	$ 0.22	—	$ 0.35	—	$ 0.22	—	$ 0.17
Number head	354	——	43	——	185	——	126	——

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[1] Prices paid as reported by farmers: Corn, $1.45 per bu.; oats, $1.00 per bu.; legume hay, $30 per ton; non-legume hay, $22 per ton; salt, $1.30 per cwt.; pasture, $1.00 per month; chore labor, $0.20 per hour.

[2] Includes shoeing, veterinary, and medicine.

Corn and legume hay were the chief feeds fed to mules on the farms surveyed. About 55 bushels of grain and 1.5 tons of hay per head were required annually with 4.5 months of pasture in addition. As indicated in Table 10, the amount of grain fed per mule increased with greater use of the workstock. However, the increase in feed costs was not directly proportional to use; consequently the cost per hour worked was lowest for the mules used the largest number of hours during the year.

Depreciation was the second largest item of expense averaging about 9 percent of the total cost. Chore labor, harness costs, and interest charges followed in the order named. All charges other than feed amounted to 22 percent of the total cost. In this analysis no charge is made for shelter, nor any credit allowed for the manure produced. These would largely offset one another, and the total cost of 22 cents per hour of workstock use can be considered as representative for the average situation on these farms in 1944.

PRODUCTION REQUIREMENTS FOR SELECTED CROPS

Physical input data are essential when it comes to planning the farm organization. Prospective tractor owners are interested in the savings in labor that can be made with the use of tractors. This section of the report presents information on the accomplishments of tractors and mules for selected operations and the labor and power required by the major crops when using different power systems. Over-all labor organizations or budgets suggesting desirable changes are not given but will be handled in a later analysis.

ACCOMPLISHMENTS OF TRACTORS AND MULES

The usual rates for performing different field operations with tractors and with mules are shown in Tables 11 and 12. Information from two sources was used in arriving at these rates. Data from the current mechanization survey were supplemented with data from another survey

TABLE 11. RATES OF ACCOMPLISHMENT FOR PERFORMING USUAL OPERATIONS WITH TRACTORS ON 62 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Implement and size*	*Acres per 10-hour day*	*Hours per acre*
Flat breaking	One-bottom plow	5.0	2.00
Flat breaking	Two-bottom plow	7.8	1.28
Bedding	One-row middle buster	9.3	1.08
Bedding	Two-row middle buster	12.4	0.81
Discing:			
Small tractor[1]	Single disc, 5 to 6 ft.	13.4	0.75
Medium tractor[2]	Single disc, 6 ft.	16.7	0.60
Small tractor[1]	Tandem disc, 5 to 6 ft.	9.5	1.05
Medium tractor[2]	Tandem disc, 5 to 6 ft.	14.3	0.70
Medium tractor[2]	Tandem disc, 7 to 8 ft.	15.4	0.65
Harrowing	Spike tooth, 10 feet	24.6	0.41
Planting (corn and cotton)	1-row planter	8.0	1.25
Planting (corn, cotton and peanuts)	2-row planter	13.9	0.72
Seeding grain	Endgate seeder	30.4	0.33
Cultivating (cotton, corn, peanuts and soybeans):			
First time over	1-row cultivator	6.7	1.49
Other times over	1-row cultivator	10.2	0.98
First time over	2-row cultivator	11.1	0.90
Other times over	2-row cultivator	17.5	0.57
Mowing hay	5-6 feet	14.4	0.69
Mowing hay	7 feet	17.3	0.58
Raking hay	Side delivery rake	22.0	0.45
Combining (small grains)	42 to 48 inches	8.6	1.16
Combining (small grains)	60 to 72 inches	12.9	0.78
Binding (small grains)	6 to 7 feet	15.3	0.65

[1] Average drawbar horse-power rating, 15.1.
[2] Average drawbar horse-power rating, 18.2.

conducted in the same area in 1943, which largely covered farms operated with mule power.[6]

The rates shown are averages. Naturally, considerable variation occurs in actual practice, depending upon the size of tractor, terrain, experience of driver, and several other factors. Some of the tractor rates will likely increase as farmers gain in experience in handling their tractors.

TABLE 12. RATES OF ACCOMPLISHMENT FOR PERFORMING USUAL OPERATIONS WITH MULES, NORTH LOUISIANA UPLAND COTTON AREA[1]

Operations	*Implement*	*Number mules*	*Acres per 10-hour day*	*Hours per acre*
Stalk cutting	1-row stalk cutter	2	7.8	1.3
Flat breaking	10-12 inch plow	2	1.8	5.6
Discing	5-foot disc (single)	2	5.3	1.9
Harrowing	2-mule harrow	2	10.0	1.0
Laying off rows	Single shovel plow	1	5.6	1.8
Bedding (one-furrow)	Middle buster	2	6.0	1.7
Bedding (two-furrows)	7-8 inch plow	1	3.0	3.3
Bedding (two-furrows)	7-10 inch plow	2	3.2	3.1
Bedding (four-furrows)	7-8 inch plow	1	1.7	5.9
Bedding (four-furrows)	7-10 inch plow	2	2.0	5.0
Harrowing beds	1-row drag	1	6.6	1.5
Fertilizing	1-row distributor	1	6.2	1.6
Planting	1-row planter	1	6.2	1.6
Cultivating:				
Bar-off (2-times row)	Turning plow	1	3.2	3.1
Sweep (2-times row)	Single stock and sweeps	1	3.2	3.1
Lay-by (2-times row)	Turning plow	1	2.5	4.0
Run middles (1-time row)	Single plow	1	5.4	1.9
Cultivating	Wheel cultivator	2	7.0	1.4
Mowing hay	4½-5 foot mower	2	6.8	1.5
Raking hay	9-10 foot dump rake	2	13.0	0.8
Plowing up peanuts	Turning plow	2	6.0	1.7
Plowing up sweetpotatoes	Turning plow	2	2.0	5.0

[1] Averages based on mechanization study and supplemented with data from a survey made in the same area in 1943.

LABOR AND POWER REQUIREMENTS

The data presented below show the labor and power needs of selected crops when using different sources of power. Although any given single case may vary from these requirements, the data are useful for making comparisons between power systems and among the different crops.

Cotton: In the North Louisiana Upland Cotton Area cotton is still produced with mules as the chief source of power. All preharvest cotton operations with the exception of chopping and hoeing can be done with tractors, however, and about half of the tractor operators interviewed were so doing. The remaining group used tractors mainly for land preparation. Data on mule requirements were taken from an earlier survey. Table 13 shows the labor and power required per acre to produce cotton under different power systems.

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[6] Sweetpotato enterprise survey in Bienville and Claiborne parishes conducted by L. J. Fenske and J. Norman Efferson, 1943.

TABLE 13. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE COTTON UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*			
			One-row equipment		*Two-row equipment*	
	Man	*Mule*	*Man*	*Tractor*	*Man*	*Tractor*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:						
Soil preparation[1]	13.8	19.4	4.1	4.1	2.7	2.7
Planting	1.6	1.6	1.3	1.3	.7	.7
Cultivating	14.3	14.3	4.4	4.4	2.6	2.6
Chopping, hoeing and sidedressing	15.8	——	14.5	——	14.5	——
Total preharvest	45.5	35.3	24.3	9.8	20.5	6.0
Total harvest[2]	36.8	3.6	36.1	——	36.1	——
All operations	82.3	38.9	60.4	9.8	56.6	6.0

[1] Includes laying off rows and fertilizing when these operations are done by mules.

[2] A truck was used 1.1 hours per acre for hauling cotton to gin on the farms using tractors.

Preharvest labor requirements were reduced 25 hours per acre from the usual mule methods when using two-row tractor equipment, while one-row tractor equipment resulted in a saving of 21 hours per acre. Roughly the labor needed prior to harvest can be lowered 50 percent when tractors instead of mules are used for all except hand operations. Moderate reductions in man labor requirements can be made even though the tractor is used only for land preparation. Although not measured here, the speed and timeliness of performing operations with tractors should result in additional advantages in favor of tractor power.

Substantial amounts of hand labor will be required in cotton production until mechanical cotton harvesting methods are perfected. The harvesting labor requirements shown in Table 13 are based on an average yield of 200 pounds of lint per acre, the average for all farms studied in 1944.

Corn: The production of corn is more adaptable to complete mechanization than cotton. Mechanical corn pickers are already in use in the major corn regions of the United States and in certain areas of

Louisiana. Even though harvesting continues to be done by hand in the hilly areas, the use of tractor power will greatly reduce man labor requirements. Table 14 presents data on the labor and power required per acre to produce corn under different power systems.

TABLE 14. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE CORN UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*					
			One-row equipment			*Two-row equipment*		
	Man	*Mule*	*Man*	*Tractor*	*Mule*	*Man*	*Tractor*	*Mule*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:								
Soil preparation[1]	7.2	12.8	3.5	3.5	—	2.6	2.6	—
Planting	1.6	1.6	1.2	1.2	—	.7	.7	—
Cultivating	11.2	11.2	3.5	3.5	—	2.0	2.0	—
Hoeing and side-dressing	4.7	—	4.7	—	—	4.7	—	—
Total preharvest	24.7	25.6	12.9	8.2	—	10.0	5.3	—
Total harvest[2]	4.5	3.0	4.5	—	3.0	4.5	—	3.0
All operations	29.2	28.6	17.4	8.2	3.0	14.5	5.3	3.0

[1] Includes laying off rows and fertilizing when these operations are done with mules.
[2] Yield, 15 bushels per acre.

Preharvest labor requirements were reduced about 48 percent when using one-row tractor equipment and 60 percent when using two-row tractor equipment. Harvest labor requirements remained the same for all groups, because no mechanical corn pickers were in use on the farms studied.

TABLE 15. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE PEANUTS UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*			*Tractor power*[1]		
	Man	*Mule*	*Tractor*	*Man*	*Mule*	*Tractor*
Preharvest:	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Soil preparation	9.0[2]	14.6[2]	—	2.1	—	2.1
Planting	1.6	1.6	—	0.7	—	0.7
Cultivating	9.3	9.3	—	2.0	—	2.0
Hoeing	8.3	—	—	8.3	—	—
Total preharvest	28.2	25.5	—	13.1	—	4.8
Total harvest	25.4	6.8	0.7	25.4	6.8	0.7
All operations	53.6	32.3	0.7	38.5	6.8	5.5

[1] Two-row equipment.
[2] Includes laying off rows and fertilizing.

Peanuts: In the early war years Louisiana farmers were encouraged to expand peanut acreages, and some gains were made, with the peak acreage coming in 1943. However, peanuts have not generally proved to be a popular cash crop except in certain localized areas. Some States have been more successful than Louisiana with mechanized production methods and this is especially true in harvesting. Two situations are shown in Table 15 with respect to labor and power requirements.

The use of a tractor reduced preharvest labor requirements for peanuts about by one-half. Additional reductions can be made by mechanizing the harvesting operations such as plowing up with a tractor, raking with a side delivery rake, and threshing from the windrow. None of the cases studied included these practices, however. The harvest labor requirements shown in Table 15 include stacking on poles and threshing in the field. They conform closely with the findings of a special peanut survey made in this area in 1943.[7]

Sweetpotatoes: Sweetpotatoes are produced mainly for home use on the North Louisiana Upland Cotton Area farms. In the vicinity of Gibsland commercial production has developed in a limited way. The data on sweetpotato labor and power requirements shown in Table 16 were derived from the 1943 survey.[8]

TABLE 16. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE SWEETPOTATOES UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*		
	Man	*Mule*	*Man*	*Mule*	*Tractor*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:					
Slip production	6.0	3.0	6.0	3.0	—
Soil preparation	13.7	24.0	9.1	10.0	2.4
Setting plants	25.0	2.6	15.0	—	2.5
Cultivating	12.0	12.0	12.0	12.0	—
Hoeing	20.0	—	20.0	—	—
Total preharvest	76.7	41.6	62.1	25.0	4.9
Total harvest	45.7	20.2	45.0	—	2.5
All operations[1]	122.4	61.8	107.1	25.0	7.4

[1] A truck was used 5 hours per acre for setting plants and hauling potatoes to storage on the farms using tractors.

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[7] Frank D. Barlow, Jr. and George Townsend, *Peanuts as a Wartime Crop in Louisiana,* Louisiana Agr. Exp. Sta. Bulletin 361, 1943, page 19.

[8] *ibid.,* page 16.

Sweetpotato operations can be mechanized to a point beyond those shown in Table 16. Cultivating can be done with tractors and mechanical diggers used if the potatoes are being produced for feed or dehydrating purposes. Bruising must be avoided, however, if the potatoes are to keep in storage. In this area sweetpotatoes are produced with mule power and the acreages per farm are small. The tractor operators reduced preharvest labor requirements by 20 percent through breaking land with tractor power and by using a mechanical setter.

Watermelons: Although not a universal crop, the production of watermelons for the market is an important enterprise on many farms in North Louisiana. Sufficient data were secured to determine labor and power requirements, and Table 17 shows the per acre requirements for mule and tractor production.

TABLE 17. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE WATERMELONS UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*		
	Man	*Mule*	*Man*	*Tractor*	*Mule*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:					
Soil preparation and fertilizing	9.9	15.5	2.8	1.8	1.0
Planting	2.2	—	2.2	—	—
Cultivating	7.2	7.2	2.8	2.8	—
Hoeing, pruning and side-dressing	5.2	—	5.2	—	—
Total preharvest	24.5	22.7	13.0	4.6	1.0
Total harvest[1]	21.2	—	21.2	—	—
All operations	45.7	22.7	34.2	4.6	1.0

[1] Includes delivery to roadside or nearby shipping point. A truck was used 6 hours per acre during harvesting operations.

A total labor reduction of 11.5 hours per acre or about 25 percent resulted from the use of tractors for land preparation and cultivating. Harvesting remains a hand operation and 21.2 man hours and 6 truck hours per acre were needed for this operation. In 1944, yields averaged 320 marketable melons per acre.

Oats for Grain: Oats acreages have more than doubled in the North Louisiana Upland Cotton Area since 1939. Labor requirements are lower for oats than for most other crops, and operations can be completely mechanized. During the period of labor shortages many farmers have added oats to their rotations.

Many methods of harvesting are used including combining, binding, and cutting with a mower for hay. Table 18 presents the labor and power required to produce oats for grain.

TABLE 18. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE OATS FOR GRAIN UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*			*Tractor power*		
	Man	*Mule*	*Tractor*	*Man*	*Mule*	*Tractor*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:						
Soil preparation	7.6	15.2	—	1.8	—	1.8
Seeding	1.2	—	—	0.6	—	0.3
Top-dressing	1.2	—	—	0.6	—	0.3
Total preharvest	10.0	15.2	—	3.0	—	2.4
Harvest with combine:						
Combining[1]	2.4	—	1.2	2.4	—	1.2
Hauling grain	0.8	0.8	—	0.8	—	0.4
Total harvest	3.2	0.8	1.2	3.2	—	1.6
Harvest with binder:						
Binding	1.4	—	0.7	1.4	—	0.7
Shocking	1.7	—	—	1.7	—	—
Hauling bundles to barn	4.4	4.4	—	4.4	4.4	—
Total harvest[2]	7.5	4.4	0.7	7.5	4.4	0.7
Total all operations:						
When combined	13.2	16.0	1.2	6.2	—	4.0
When cut with binder	17.5	19.6	0.7	10.5	4.4	3.1

[1] Four-foot cut.

[2] Bundles fed. No threshing involved.

Preharvest labor requirements can be reduced by two-thirds when tractors are used for producing oats. Harvesting can be done most effectively with a combine. Threshing with stationary rigs was not reported on the farms supplying detailed information on oats, hence, the labor requirements shown in Table 18 do not include this method of harvesting. Several farmers cut their grain with binders and then hauled the bundles to the barn for storage to be fed later in bundle form or chopped in a hammer mill before feeding to livestock.

Oats for Hay: The practice of cutting oats for hay is followed on many of the smaller farms in this section. Data on labor and power needs for oat hay production are given in Table 19.

TABLE 19. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE OATS FOR HAY UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*		
	Man	*Mule*	*Man*	*Tractor*	*Mule*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest[1]	10.0	15.2	3.0	2.4	—
Harvest:					
Mow	1.5	3.0	0.7	0.7	—
Rake and bunch	1.2	2.4	1.2	—	2.4
Haul to barn (loose)	5.2	3.5	5.2	—	3.5
Total harvest[2]	7.9	8.9	7.1	0.7	5.9
Total all operations	17.9	24.1	10.1	3.1	5.9

[1] Details for preharvest shown in Table 18.

[2] Average yield, 1.2 ton per acre.

On farms with tractors the mowing was done with tractors, but raking usually was done with mules. The hay was generally stored loose in barns or sheds. Labor requirements were reduced 7.8 hours per acre or about 40 percent when tractors were used as the source of power.

Soybeans for Hay: Soybeans are grown alone for hay on some farms in North Louisiana. They are produced much like corn until harvest time. Table 20 shows the labor and power required per acre to produce soybean hay with mules and with tractors.

TABLE 20. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE SOYBEANS FOR HAY UNDER DIFFERENT POWER SYSTEMS IN THE NORTH LOUISIANA UPLAND COTTON AREA

Operations	*Mule power*		*Tractor power*		
	Man	*Mule*	*Man*	*Tractor*	*Mule*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:					
Soil preparation	8.2	14.8	1.8	1.8	—
Seeding	1.6	1.6	0.7	0.7	—
Cultivation	9.3	9.3	2.0	2.0	—
Total preharvest	19.1	25.7	4.5	4.5	—
Harvest:					
Mow	1.5	3.0	0.7	0.7	—
Rake and bunch	1.2	2.4	1.2	—	2.4
Haul to barn (loose)	4.5	3.0	4.5	—	3.0
Total[1]	7.2	8.4	6.4	0.7	5.4
Total all operations	26.3	34.1	10.9	5.2	5.4

[1] Average yield, 1.0 ton per acre.

Soybean operations can be completely mechanized and labor requirements greatly reduced. A saving of over 50 percent in man labor resulted from mechanizing preharvest operations, and mowing with a tractor mower.

Lespedeza: Lespedeza serves as a hay and pasture crop in North Louisiana. Seedings are made after oats or on a seedbed especially prepared for lespedeza. From 2 to 3 man hours per acre are required for establishing the crop and for fertilizing when seeded after oats. On the farms surveyed it is a common practice to leave the lespedeza meadows remain for two and sometimes three years before re-seeding.

Table 21 shows labor and power data for producing lespedeza hay.

TABLE 21. LABOR AND POWER REQUIRED PER ACRE TO PRODUCE LESPEDEZA HAY UNDER DIFFERENT POWER SYSTEMS, NORTH LOUISIANA UPLAND COTTON AREA

	Mule power		*Tractor power*	
Operations	*Man*	*Mule*	*Man*	*Tractor*
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*
Preharvest:				
Broadcast seed	1.2	—	1.2	—
Broadcast fertilizer	1.2	—	1.2	—
Total preharvest[1]	2.4	—	2.4	—
Harvest:				
Mow	1.5	3.0	0.7	0.7
Windrow	0.8	1.6	0.5	0.5
Rake to baler	1.4	2.8	0.8	0.8
Bale	7.0	1.4	3.2	[2]
Haul bales	1.7	1.7	1.3	[3]
Total harvest	12.4	10.5	6.5	2.0
Total all operations[4]	14.8	10.5	8.9	2.0

[1] Seeded after oats.
[2] Stationary baler with motor.
[3] A truck was used 0.7 hours per acre for hauling bales.
[4] Average yield 1.0 ton per acre (one cutting).

Mule-powered balers are not uncommon in this area. Approximately 200 bales per 10-hour day can be baled with mule-powered balers, while tractor- or motor-powered stationary balers averaged 385 bales per 10-hour day. Hay harvesting labor requirements were reduced about 6.0 hours or 40 percent by using tractor power.

MATERIALS USED IN CROP PRODUCTION

It is desirable to understand all material inputs as well as labor and power requirements in crop production in order to evaluate different enterprises in cropping systems. The data shown in Table 22 are averages derived from the actual records and should not be taken to represent recommended practices.

TABLE 22. AVERAGE AMOUNTS OF SEED, FERTILIZERS, AND OTHER MATERIALS USED PER ACRE FOR SELECTED CROPS, NORTH LOUISIANA UPLAND COTTON AREA, 1944

Crop	*Seed*		*Fertilizers*				*Other materials*	
			Mixed		*Other*			
	Unit	*Amt.*	*Kind*	*Lbs.*	*Kind*	*Lbs.*	*Kind*	*No.*
Cotton, upland	Lb.	25	6-8-4[1]	200	Nitrate[2]	100	—	—
Corn, alone	Lb.	7	6-8-4[1]	100	Nitrate[2]	100	—	—
Oats for grain	Bu.	3	—	—	Nitrate[2]	135	Sacks	10
Lespedeza for hay	Lb.	25	—	—	Acid Phos.	200	—	—
Soybeans for hay	Lb.	40	—	—	—	—	—	—
Watermelons	Lb.	1	6-8-4[1]	400	Nitrate[2]	100	—	—
Sweetpotatoes	Bu.	6	4-12-4	300	—	—	Crates	70
Peanuts	Lb.	40	6-8-4	185	—	—	Sacks	5

[1] 5-10-5 fertilizer also extensively used.
[2] Usually nitrate of soda.

The amounts of fertilizers used are less than the recommended rates in all cases. However, the average applications are higher on the group studied than for all farms in the area. The grades used were governed very largely by availability, but they conform closely to the ones recommended.

PRODUCTION COSTS AND RETURNS FOR SELECTED CROPS

This section of the report considers the economic aspects of crop production in the North Louisiana Upland Cotton Area. In 1944 farm wage rates were higher than usual as were nearly all other expense items. Farm prices were relatively high, however, and most crops yielded fairly satisfactory monetary returns. Crop yields were slightly below normal for most crops, while the corn crop was extremely poor (Appendix Table 4).

CASH CROPS

Cotton is the leading cash crop in the area and as yet has no serious competitors when measured from an acreage standpoint. Peanuts, sweetpotatoes, and watermelons are minor cash crops, although they are of considerable importance on certain farms. Table 23 shows the per acre income, costs and returns for the above mentioned crops in 1944.

The measure *returns to labor* is used in this analysis, and it is obtained by subtracting all costs except labor from the total income. The balance is allocated to labor as wages. Actually this measure includes the return to management as well as labor. Returns per man hour were obtained by dividing the returns per acre by the number of man hours required per acre to produce the crop. It should be cautioned that the results for a single year cannot be used for selecting the most profitable crop enterprises over the long-run period, and the data in Table 23 are shown mainly to compare the returns for an individual crop when using different sources of power.

TABLE 23. AVERAGE INCOME, PRODUCTION COSTS, AND RETURNS TO LABOR PER ACRE, AND RETURNS TO LABOR PER HOUR FROM COTTON, PEANUTS, SWEETPOTATOES AND WATERMELONS, NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item	*Cotton*		*Peanuts*		*Sweetpotatoes*		*Watermelons*	
	Mule	*Tractor*	*Mule*	*Tractor*	*Mule*	*Tractor*	*Mule*	*Tractor*
Total income per acre[1]	$50.10	$50.10	$46.00	$46.00	$106.00	$106.00	$72.00	$72.00
Production expenses per acre:								
Direct cash expenses[2]	$10.50	$10.50	$12.52	$12.52	$ 17.82	$ 17.82	$11.40	$11.40
Tractor power	——	2.64	——	2.11	——	3.26	——	2.02
Mule work	8.56	——	7.10	1.50	13.60	7.70	4.99	.22
Equipment charges[3]	1.28	1.34	1.57	1.25	2.04	2.73	1.64	1.65
Land charges[4]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total	$22.34	$16.48	$23.19	$19.38	$ 35.46	$ 33.51	$20.03	$17.29
Returns to labor per acre	$27.76	$33.62	$22.81	$26.62	$ 70.54	$ 72.49	$51.97	$54.71
Man hours per acre	82.3	56.6	51.5[5]	36.4[5]	122.4	107.1	45.7	34.2
Returns to labor per hour	$ 0.34	$ 0.59	$ 0.44	$ 0.73	$ 0.58	$ 0.68	$ 1.14	$ 1.60

[1] Data for income calculations given in Appendix Table 4.
[2] Includes seed, fertilizers, containers, and hired services such as ginning, peanut picking, etc.
[3] Includes truck charges in those cases where a truck was used.
[4] Calculated at 5 percent of $40 per acre.
[5] Excluding labor furnished by picker operator.

The reduction in labor secured by the use of tractors can be effectively transmitted into lower costs and higher returns, provided the labor and other resources released can be utilized to advantage elsewhere. In 1944 tractor methods had an advantage over mule methods both in the returns to labor per acre and per hour for all cash crops. In this analysis the yields were left the same for each method of production, because for the year under consideration no appreciable differences were noted between the two groups. This may not always be the case and tractor production may show an advantage in yields because of the timeliness in performing different operations, and in thoroughness of doing the job.

At 1944 yields and prices, cotton produced with tractors returned 59 cents per man hour; sweet potatoes, 68 cents; peanuts, 73 cents; and watermelons, $1.60. When mules were used exclusively cotton returned 34 cents per man hour; peanuts, 44 cents; sweetpotatoes, 58 cents; and watermelons, $1.14. As stated previously, the long-run situation must be considered when selecting crop enterprises. Under most circumstances it would not be advisable to devote all production resources to the enterprise showing the highest returns to labor per hour. Full utilization of resources is desired, and usually this cannot be attained except through a balance among enterprises.

FEED CROPS

Table 24 shows the per acre income, costs, and returns for the feed crops, including corn, oats for grain, oats for hay, and lespedeza hay.

The advantages of tractor production are again illustrated by this group of crops. In each case returns to labor per acre and per hour were higher under tractor than under mule production methods.

TABLE 24. AVERAGE INCOME, PRODUCTION COSTS, AND RETURNS TO LABOR PER ACRE, AND RETURNS TO LABOR PER HOUR FROM MAJOR FEED CROPS, NORTH LOUISIANA UPLAND COTTON AREA, 1944

Item	*Corn*		*Oats for grain*		*Oats for hay*		*Lespedeza*[1]	
	Mule	*Tractor*	*Mule*	*Tractor*	*Mule*	*Tractor*	*Mule*	*Tractor*
Value production per acre[2]	$14.50	$14.50	$30.00	$30.00	$19.80	$19.80	$22.00	$22.00
Production expenses per acre:								
Direct cash expenses[3]	4.40	4.40	13.30	13.30	6.60	6.60	4.95	4.95
Tractor power	——	2.33	——	1.23	——	1.36	——	.88
Mule work	6.29	.66	3.52	——	5.30	1.30	2.31	——
Equipment charges	.94	.93	.53	.44	.80	1.25	.55	.87
Land charges[4]	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Total	$13.63	$10.32	$19.53	$16.97	$14.70	$12.51	$ 9.81	$ 8.70
Returns to labor per acre	.87	4.18	10.47	13.03	5.10	7.29	12.19	13.30
Man hours per acre	29.2	14.5	10.8[5]	3.8[5]	17.9	10.1	14.8	8.9
Returns to labor per hour	$ 0.03	$ 0.29	$ 0.97	$ 3.44	$ 0.28	$ 0.72	$ 0.82	$ 1.50

[1] One cutting. About one-half of the acreage was cut twice.

[2] Data for income calculations given in Appendix Table 4.

[3] Includes seed, fertilizers, sacks, custom combining, etc.

[4] Calculated at 5 percent of $40 per acre.

[5] Does not include labor furnished by combine operator.

Corn showed up at a relatively disadvantage in 1944 because corn yields were extremely low. The high hourly returns for oats and lespedeza are due largely to the low labor requirements for these crops. A comparison will show that the return to labor per acre for the cash crops were well above similar returns for the feed crops.

SUMMARY

1. Tractors on farms in the North Louisiana Upland Cotton Area increased from 104 in 1930 to 288 by 1940, and to 661 by 1944. A still greater expansion in numbers is expected in the immediate postwar years.

2. The tractor farms surveyed were considerably larger than the usual farm in the area, averaging 135.5 acres of tilled cropland per farm in 1944. In any area the operators of the larger farms are usually the first to mechanize inasmuch as the maximum economies made possible through mechanization can be realized only if the equipment is used at near capacity.

3. The value of machinery inventories averaged $2,365 per farm with 78 percent of the total machinery investment being in tractors and tractor equipment and the remaining 22 percent in mule-drawn equipment.

4. The annual cost of operating tractor equipment commonly found averaged $160 per farm, while the annual cost of operating mule equipment averaged $128 per farm. Unusual items such as hay balers, combines, and peanut pickers are not included in the above averages.

5. Tractor operating costs averaged $4.22 per 10-hour day of use for all tractors studied; consisting of $2.98 for cash expenses, and $1.24 for overhead costs. One-plow tractor costs averaged $3.88 per 10-hour day; two-plow tractors of less than 17 drawbar horsepower, $4.05 per day; and two-plow tractors of 17 horsepower and over, $4.87 per day.

6. Workstock costs averaged $161.12 per head in 1944. Feed charges including pasture, comprised 78 percent of the total costs, while depreciation, interest, chore labor, harness costs, and miscellaneous items made up the remaining 22 percent. The cost per hour declined with use. Average costs for all head amounted to 22 cents per hour of use in 1944.

7. On an average three mules were displaced by each tractor purchased. Mules have not been reduced to a minimum, hence, over-all power costs on some farms can be lowered still further.

8. The amounts of man labor used per acre for the different crops was substantially less with tractor-drawn equipment than when mules were used. Savings in labor through the use of tractors ranged from 25 to 60 percent depending upon the crop and the extent of mechanization. The chief reductions in labor were made in preharvest operations, because harvesting operations for most of the crops have not become fully mechanized.

9. Production costs were reduced through the use of tractors, and the returns to labor for each specific crop were greatest when operations were highly mechanized as compared with mule production methods.

APPENDIX TABLE 1. AVERAGE PURCHASE PRICE AND ANNUAL COST OF OPERATING TRACTOR EQUIPMENT PER MACHINE ON 62 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA

					Average annual cost per machine			
Item	*Average purchase price*[1]	*Present age*	*Remaining life*	*Total estimated life*	*Depreciation*[2]	*Repair and upkeep*[3]	*Interest*[4]	*Total*
	Dol.	*Yrs.*	*Yrs.*	*Yrs.*	*Dol.*	*Dol.*	*Dol.*	*Dol.*
Tandem disc	160	4.4	7.5	11.9	13.45	22.22	4.00	39.67
Single disc	109	3.8	9.5	13.3	8.20	16.86	2.73	27.79
Plow, 1-bottom	82	4.3	12.0	16.3	5.03	9.29	2.05	16.37
Plow, 2-bottom	120	3.8	8.6	12.4	9.68	17.71	3.00	30.39
Middlebuster, 1-row	64	2.6	11.0	13.6	4.70	5.89	1.60	12.19
Middlebuster, 2-row	107	4.2	8.7	12.9	8.29	9.40	2.68	20.37
Disc plow, 1-pan	142	2.5	9.7	12.2	11.64	9.75	3.55	24.94
Disc plow, 2-pans	186	2.6	9.6	12.2	15.25	15.64	4.65	35.54
Section harrow	35	5.1	6.3	11.4	3.07	3.67	.88	7.62
Planters, 1-row	85	2.9	10.9	13.8	7.16	6.25	2.13	15.54
Planters, 2-row	138	3.0	9.1	12.1	11.40	8.66	3.45	23.51
Cultivators, 1-row	82	2.9	10.7	13.6	6.03	13.69	2.05	21.77
Cultivators, 2-row	145	3.2	9.5	12.7	11.42	15.52	3.65	30.59
Grain drill	167	2.4	9.0	11.4	14.65	10.14	4.18	28.97
Mower	149	2.9	7.3	10.2	14.61	17.67	3.73	36.01
Rake, side delivery	167	2.2	6.2	8.4	19.88	8.90	4.18	32.96
Grain binder	297	3.8	5.5	9.3	31.93	37.50	7.43	76.86
Scoops and slips	79	2.4	11.8	14.2	5.56	2.64	1.98	10.18
Stalk cutter	92	3.2	10.8	14.0	6.57	4.80	2.30	13.67
Manure spreader	200	2.8	6.8	9.6	20.83	12.40	5.00	38.23
Hammer mill	210	3.4	10.7	14.1	14.89	6.50	5.25	26.64
Wood saw	42	4.7	9.3	14.0	3.00	3.00	1.05	7.05
Endgate seeder	44	3.5	8.5	12.0	3.67	7.50	1.10	12.27
Tillage tool	105	2.7	10.1	12.8	8.20	5.86	2.63	16.69
Cotton duster	180	4.0	6.5	10.5	17.14	2.50	4.50	24.14
Lime spreader	190	2.0	9.0	11.0	17.27	7.33	4.75	29.35
Terrace drag	146	6.0	11.3	17.3	8.46	5.00	3.66	17.12
Cultipacker	128	2.0	13.0	15.0	8.53	5.00	3.20	16.73
Combine	586	2.0	8.0	10.0	58.60	38.83	14.65	112.08
Baler, stationary	525	3.3	12.1	15.4	34.09	12.20	13.13	59.42

[1] New cost basis.

[2] Depreciated by straight-line method.

[3] Based on farmers' estimates.

[4] Calculated at 5 percent of one-half new cost.

APPENDIX TABLE 2. AVERAGE PURCHASE PRICE AND ANNUAL COST OF OPERATING MULE-DRAWN EQUIPMENT PER IMPLEMENT ON 62 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA

Implement	*Average purchase price*[1]	*Total estimated life*	*Average annual cost per implement*			
			Depreciation[2]	*Repairs and upkeep*[3]	*Interest*[4]	*Total*
	Dollars	*Years*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Turning plow, single	8.93	13.8	0.65	2.25	0.22	3.12
Turning plow, double	21.86	14.3	1.53	4.02	.55	6.10
Disc, 2 horse	62.50	11.0	5.68	3.50	1.56	10.74
Middlebuster	22.76	14.2	1.60	3.90	.57	6.07
Harrow, section	29.88	14.3	2.09	1.45	.75	4.29
Planter, 1-row	24.97	10.8	2.31	2.34	.62	5.27
Fert. distributor, 1-row	15.91	8.6	1.85	1.80	.40	4.05
Walking cultivator	65.12	12.7	5.13	6.24	1.63	13.00
Gee whiz cultivator	9.22	11.8	.78	1.42	.23	2.43
Georgia stock	3.46	11.2	.31	3.18	.09	3.58
Hay mower	115.67	11.2	10.33	8.86	2.89	22.08
Hay rake, dump	61.70	14.1	4.38	2.99	1.54	8.91
Wagon	127.41	17.6	7.24	8.90	3.19	19.33

[1] New cost basis.
[2] Depreciated by straight line method.
[3] Based on farmers' estimates.
[4] Calculated at 5 percent of one-half new cost.

APPENDIX TABLE 3. AVERAGE LIFE OF TRACTOR TIRES BY SIZE OF TRACTOR AS ESTIMATED BY FARMERS REPORTING, NORTH LOUISIANA UPLAND COTTON AREA

Group	*Front tires*	*Back tires*
	Years	*Years*
One-plow tractors	5.5	7.0
Two-plow tractors:		
Less 17 H.. P.	4.9	5.5
17 H. P. and over	5.2	6.6
All tractors	5.2	6.3

APPENDIX TABLE 4. AVERAGE PRICES RECEIVED AND YIELDS PER ACRE FOR SELECTED CROPS ON 62 FARMS IN THE NORTH LOUISIANA UPLAND COTTON AREA, 1944

Crop	*Unit*	*Price per unit, 1944*	*Yield per acre*	
			1944	*Normal*
Cotton, lint	Lb.	$ 0.209	200	277
Cottonseed	Lb.	.025	325	—
Peanuts	Lb.	.08	500	650
Peanut hay	Ton	16.50	0.4	—
Watermelons	No.	.225	320	465
Sweetpotatoes[1]	Bu.	1.30	70	100
Corn	Bu.	1.45	10	19.4
Oats	Bu.	1.00	30	34.0
Oats for hay	Ton	16.50	1.2	1.4
Lespedeza[2]	Ton	22.00	1.5	2.0

[1] Number 1 potatoes.

[2] All cuttings. Average 1.5 times per season.

APPENDIX TABLE 5. RATES OF ACCOMPLISHMENT FOR HAND OPERATIONS, NORTH LOUISIANA UPLAND COTTON AREA[1]

Operations	*Crew*		*Unit*	*Amount per 10-hour day*	*Hours per acre*
	Men	*Mules*			
Setting sweet potato slips	1	—	acre	0.4	25.0
Side-dressing with fertilizer	1	—	acre	6.3	1.6
Broadcasting fertilizer	1	—	acre	8.6	1.2
Broadcasting small grains	1	—	acre	8.6	1.2
Chopping cotton (first time)	1	—	acre	1.0	10.0
Hoeing cotton (second time)	1	—	acre	1.2	8.3
Hoeing peanuts	1	—	acre	1.2	8.3
Thinning corn	1	—	acre	3.2	3.1
Hoeing sweet potatoes	1	—	acre	0.6	16.7
Windrowing peanuts	1	—	acre	2.0	5.0
Stacking peanuts on poles	1	—	acre	.54	18.6
Shocking small grains	1	—	acre	6.0	1.7
Picking cotton	1	—	lbs.	165.0	35.0[2]
Pull and heap corn	1	—	bu.	50.0	3.0[3]
Haul corn from heaps to crib	2	2	bu.	150.0	2.0[3]
Pull, load, haul, and unload corn in crib	3	2	bu.	100.0	4.5[3]
Haul hay loose to barn	3	2	ton	6.9	5.7[4]

[1] Averages based on mechanization study and supplemented with data from a survey made in the same area in 1943.

[2] Cotton yielding 200 pounds lint per acre.

[3] Corn yielding 15 bushels per acre.

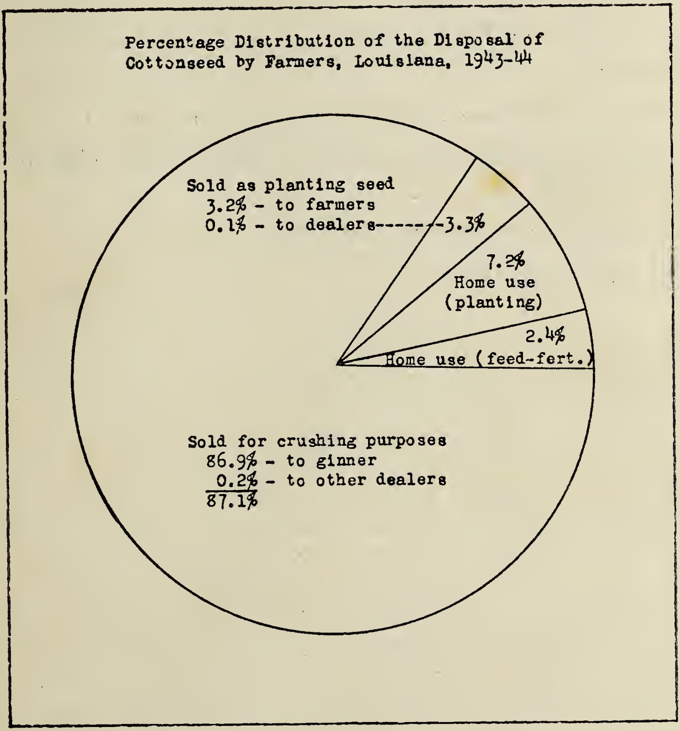
[4] Hay yielding 1.3 tons per acre.

LOUISIANA BULLETIN NO. 400 JANUARY, 1946

MARKETING OF COTTONSEED IN LOUISIANA

By

JAMES F. HUDSON



LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
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MARKETING OF COTTONSEED IN LOUISIANA

By

JAMES F. HUDSON*

GROWTH IN THE IMPORTANCE OF COTTONSEED

Cotton lint has been a valuable commodity for more than 2,000 years, but it was in comparatively recent years that American ingenuity found uses for cottonseed which transformed it into a commodity of great commercial value and importance. Cottonseed oil was first produced in the United States in about 1768. In the beginning it was used experimentally as an oil in paints, an illuminant, a lubricant, and as a food for livestock. The oil made its initial appearance in food for human consumption in about 1855, as an ingredient used in tempering lard to be consumed in cold climates.

The first commercial cottonseed oil mill in this locality was constructed at Natchez, Mississippi, in 1834.[1] The extraction of oil was the main purpose of the early cottonseed oil mills, but other products developed to such an extent that the only element now discarded in the manufacturing process is the dirt removed from the seed. The discovery of the many new uses for crude products from cottonseed has been the chief factor in the growth of the cottonseed processing industry. During the 1943-44 season, approximately 86 per cent of the cottonseed produced in the United States, and 89 per cent of that produced in Louisiana was crushed by the cottonseed oil mills (Table I).

Following the invention of the cotton gin by Eli Whitney in 1793, the production of cotton increased rapidly and cottonseed, being a joint product with cotton lint, also increased. Because there was little demand for its products, only five to ten per cent of the cottonseed produced prior to 1881 was processed in cottonseed oil mills. Cottonseed was used for planting and, to some extent, as feed for livestock and as fertilizer. The bulk of the cottonseed produced was left at the gin and because the rotting seeds were thought to be a menace to health, the ginner frequently hired someone to haul them away.

Shortly after the Civil War, the demand for cottonseed products was large enough to utilize all that were produced. As a result, the industry grew rapidly and mills were built all over the Cotton Belt. The number of mills in the United States increased from 7 in 1860 to 870 in 1913 (Table II). Since 1913 there has been a considerable reduction in the number of oil mills crushing less than 10,000 tons of cottonseed and an increase in the number of mills crushing more than 10,000 tons. By 1944 the number of active mills had been reduced to 394.

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*The author wishes to acknowledge the helpful assistance given by Dr. B. M. Gile in planning this study and in the development of the manuscript.

[1] *Cottonseed and Its Products* (Memphis: National Cottonseed Products Association, Inc., 1937), p. 8.

As the industry developed, farmers became more concerned over the prices received for their cottonseed. Cottonseed oil mills began to take more interest in the quality of the cottonseed, and they organized an association for the purpose of improving and regulating their business. About 1911 the industry called upon the United States Department of Agriculture for assistance in formulating rules for grading cottonseed, and in combating the gin practice of adulterating the seed with trash before delivering it to the mills. After many years of study in cooperation with the industry, the United States Department of Agriculture has developed a system of cottonseed grading. The system of grading used during the 1943-44 season was based upon the amount of oil, ammonia, moisture and foreign matter present in the seed and the percentage of free fatty acids in the oil in the seed. Cottonseed containing a certain quantity of the above constituents of a given quality was called "basis" grade seed and graded 100. In buying seed "on grade," the mill offers a price for "basis" seed. A sample of the purchased seed is chemically analyzed by a chemist licensed by the Department of Agriculture. If the seed grades above 100, the seller receives a premium; if it grades below 100, he receives a discount from the base price.

Table I. ESTIMATED QUANTITY OF COTTONSEED PRODUCED, QUANTITY CRUSHED AND PERCENTAGE OF PRODUCTION CRUSHED IN THE UNITED STATES AND LOUISIANA, FOR SELECTED YEARS, 1874-1943

YEAR*	UNITED STATES			LOUISIANA		
	Production	Crushings	Crushings as percentage of production	Production	Crushings	Crushings as percentage of production
	1,000 tons	1,000 tons	Per cent	1,000 tons	1,000 tons	Per cent
1874	1,687	84	5	‡	‡	‡
1881	2,455	295	12	‡	‡	‡
1890	4,093	1,023	25	‡	‡	‡
1905	5,060	3,131	62	246	181	74
1910	5,175	4,106	79	109	80	73
1920	5,971	4,069	68	172	120	70
1930	6,028	4,695	78	330	255	77
1935	4,634	3,750	81	251	210	84
1940	5,286	4,490	85	191	163	85
1941	4,553	3,960	87	135	115	85
1942	5,202	4,516	87	243	220	91
1943†	4,688	4,046	86	299	265	89
1940-43 average	4,932	4,253	86	217	191	88

*Crop year beginning August. †Preliminary. ‡Not available.

SOURCES: Bureau of the Census, *Cotton Production and Disposition*, Bulletins 1-181; Bureau of Agricultural Economics, *Farm Production, Farm Disposition, and Value of Cotton and Cottonseed and Related Data, 1928-42.* June 1944.

Cottonseed became a vital commodity during World War II, because of the strategic importance of its products and the great reduction in the amount of fats and oils usually imported into the United States. Cottonseed cake and meal and cottonseed hulls, used in the production of livestock products, were important factors in the "Food for Freedom" program. Cottonseed linters were under allocation by the War Production Board, and went to war in the form of smokeless powder for the armed forces.

Table II. NUMBER OF COTTONSEED OIL MILLS IN THE UNITED STATES AND LOUISIANA IN SELECTED YEARS, 1860-1944

AREA	NUMBER OF OIL MILLS BY YEARS							
	1860	1870	1880	1890	1900	1905	1909	1913
United States	7	26	45	119	369	715	817	870
Louisiana	3	6	12	7	24	51	43	32
AREA	1920	1930	1935	1940	1941	1942	1943	1944
United States	675	520	478	446	446	426	410	394
Louisiana	22	19	18	19	19	18	18	18

SOURCES: Bureau of Census, *Cotton Production and Distribution,* Bulletins 101-181; *Census of Manufactures, 1860-1900.*

FARM INCOME FROM COTTONSEED

Cottonseed production in the 1943-44 cotton season in Louisiana was 299,000 tons compared with 243,000 tons in 1942-43, and 135,000 tons in 1941-42. Production in the United States was 4,688,000 tons in 1943-44, 5,202,000 tons in 1942-43, and 4,553,000 tons in 1941-42 (Table III).

The estimated farm value of the production of cottonseed in Louisiana was $15,428,000 in 1943-44, $10,799,000 in 1942-43, and $6,418,000 in 1941-42. The value of the production in the United States was $244,052,000 in 1943-44, $237,221,000 in 1942-43, and $216,961,000 in 1941-42 (Table III). Cottonseed ranked fifth in value of major farm crops produced in Louisiana during the ten-year period 1932-41.

Small cotton farm owners, tenants, and sharecroppers depend upon the income from cottonseed to pay the costs of harvesting and ginning the cotton crop. Farmers who borrow money to produce their crop have their first bales of lint cotton obligated as payment of these debts. In such cases, the income from cottonseed is their only source of cash at harvest time and must support them until enough lint is sold to liquidate their debts.

Table III. PRODUCTION, PRICE RECEIVED BY FARMERS AND VALUE OF COTTONSEED, LOUISIANA AND THE UNITED STATES, 1928-43

YEAR*	LOUISIANA				UNITED STATES			
	Production	Season average price received by farmers per ton	Value		Production	Season average price received by farmers per ton	Value	
			Production	Sales			Production	Sales
	1,000 tons	Dollars	1,000 Dollars		1,000 tons	Dollars	1,000 Dollars	
1928	326	31.76	10,354	8,734	6,319	34.17	216,191	173,754
1929	376	29.60	11,130	8,880	6,406	20.92	198,164	155,288
1930	330	21.28	7,022	5,426	6,028	22.04	133,054	103,492
1931	416	7.67	3,191	2,454	7,310	8.97	65,678	50,432
1932	290	10.11	2,932	2,325	5,815	10.33	60,202	46,945
1933	223	12.20	2,721	2,196	5,511	12.88	71,166	53,571
1934	225	31.78	7,150	6,197	4,356	33.00	140,574	112,782
1935	251	30.35	7,618	6,374	4,634	30.54	141,527	114,522
1936	349	33.77	11,786	9,624	5,472	33.36	182,230	150,767
1937	454	18.79	8,531	7,140	7,844	19.51	152,974	129,208
1938	278	20.58	5,721	4,836	4,950	21.79	107,874	92,806
1939	304	19.24	5,849	5,099	4,869	21.17	102,933	86,150
1940	191	20.32	3,881	3,312	5,286	21.73	114,817	97,552
1941	135	47.54	6,418	5,467	4,553	47.65	216,961	188,691
1942	243	44.44	10,799	9,777	5,202	45.61	237,221	205,974
1943	299	51.60	15,428	13,416	4,688	52.08	244,052	210,720
1940-43 average	217	40.97	9,132	8,058	4,932	41.77	203,263	175,734

* Crop year beginning August.

SOURCE: Bureau of Agricultural Economics, *Farm Production, Farm Disposition, and Value of Cotton and Cottonseed and Related Data, 1928-42.* June 1944.

The main purposes of this report are to analyze the agencies used by farmers in marketing cottonseed, the buying and selling practices of ginners, and the relationship between the average farm price of cottonseed and the value of the products obtained from cottonseed. Most of the data on methods and practices used in marketing cottonseed in Louisiana were obained by using the survey method. Schedules pertaining to practices of individual farmers were taken in parishes selected as being representative of the four cotton grade and staple reporting districts of the State established by the Cotton and Fiber Division of the War Food Administration. Most of the farm schedules were taken from farmers who were patrons of the ginning establishments from which data were obtained. By following this procedure it was possible to check one source of data against the other on certain items and enhance the reliability and accuracy of the data.

The schedules of gin information were obtained from those gins used by the Cotton and Fiber Division of the War Food Administration in preparing their Cotton Quality Reports. The division selects gins

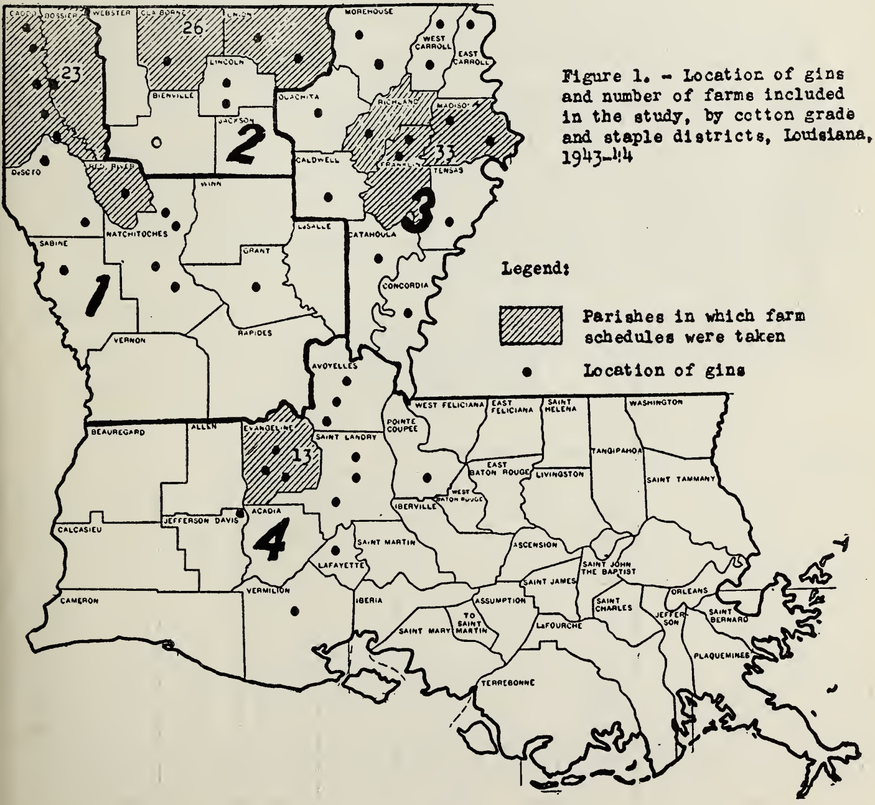

Figure 1. - Location of gins and number of farms included in the study, by cotton grade and staple districts, Louisiana, 1943-44

Legend:

▨ Parishes in which farm schedules were taken

● Location of gins

representative of those located in each district, a large enough number being selected so that their total volume of ginnings will represent approximately ten per cent of the ginnings in the district.

Ninety-five schedules were obtained from farmers: 23 in District I, 26 in District II, 33 in District III, and 13 in District IV (Figure 1). Of the farmers interviewed, 42 were farm owners, 7 cash renters, 1 standing renter, 17 third and fourth share renters, 7 third share renters, and 21 one-half share renters. The data obtained from the farm schedules were supplemented by data pertaining to farm practices included in the gin schedules.

Forty-nine schedules were obtained from ginners: 15 in District I, 6 in District II, 15 in District III, and 13 in District IV (Figure 1). The gins from which data were obtained had an average ginning volume of 1,734 bales per gin as compared with the State average of 1,315 bales as reported by the United States Department of Commerce, Bureau of the Census. Seventeen gins were owned by individuals, 11 were partnerships, 6 were owned by estates, and 15 were incorporated. The average capital investment in the gin establishments was $24,632 in District I, $16,800 in District II, $22,000 in District III, and $21,600 in District IV.

PROPORTION OF COTTONSEED SOLD

During the 1943-44 season, the farmers sold 87.1 per cent of their cottonseed for crushing purposes; 86.9 per cent to the ginner handling the farmers' cotton and 0.2 per cent direct to the cottonseed oil mill and to other dealers (Table IV). They retained 12.9 per cent of their cottonseed of which 3.2 per cent was sold to neighbors and other farmers as planting seed, 0.1 per cent was sold to planting seed dealers, 7.2 per cent was used on the farm as planting seed, and 2.4 per cent was used as feed for livestock and as fertilizer on the farm.

Table IV. PERCENTAGE DISTRIBUTION OF THE DISPOSAL OF COTTONSEED BY FARMERS, LOUISIANA, 1943-44

DISTRICT	DISPOSITION OF COTTONSEED REPORTED BY FARMERS							
	Sold for crushing			Retained on farm				Total production
	Sold to gin	Sold to other dealers	Total	Planting seed		Feed and fertilizer	Total	
				Sale	Home use			
	Per cent			Per cent				Per cent
I	83.6	0.0	83.6	7.0	7.4	2.0	16.4	100
II	81.2	0.0	81.2	0.0	10.1	8.7	18.8	100
III	91.0	0.4	91.4	0.7	6.9	1.0	8.6	100
IV	93.3	0.0	93.3	0.0	1.8	4.9	6.7	100
Average................	86.9	0.2	87.1	3.3	7.2	2.4	12.9	100

The general practice followed by farmers is to bring home a sufficient amount of cottonseed to plant, and if necessary, replant their expected acreage of cotton the following season; in addition, they allow for enough to supplement their livestock feed supply during the winter months. The amount of cottonseed retained by farmers to be used as feed for livestock tends to fluctuate more from season to season than that used for planting. Although it was found that some farmers, due to custom and personal preference, feed whole cottonseed to their livestock, regardless of price relationships, the majority of farmers expect a ton of cottonseed to exchange for a ton of cottonseed meal or the price of both should exist in that ratio. The amount of cottonseed retained by growers as livestock feed is affected considerably by this ratio and also by the supply and availability of the cottonseed meal.

There was very little change in the amount of cottonseed retained for home use by farmers during the 1943-44 season compared with that of the 1942-43 season (Table V). If there were any change at all, it has been toward a reduction, rather than an increase, in amount. The farm price of cottonseed has been considerably higher during the past three years than it was prior to 1941, and somewhat higher in 1943 than in 1942; also the price of cottonseed has been favorable in respect to cottonseed meal prices during the two seasons. These facts would lead one to expect a reduction in the amounts of cottonseed retained for feed, but due to shortages of feed and scarcity of cottonseed meal and hulls, the reduction has been very small. A factor which influenced farmers not to increase the amount of cottonseed retained for home use was the increased wartime needs for oil seeds. Farmers were asked to sell the bulk of their cottonseed crop, retaining only enough for planting, so that the supply of the much needed oil products might be obtained.

A few farmers specialize in selling certified planting seed and sell their entire crop as such, but the percentage of the total cottonseed pro-

Table V. CHANGES IN THE RELATIVE AMOUNTS OF COTTONSEED CARRIED HOME BY FARMERS DURING 1943 AS COMPARED TO 1942, LOUISIANA

DISTRICT	FARMERS REPORTING			
	Cottonseed carried home in 1943 compared to 1942			Total reporting
	More	Less	Same	
	Number			Number
I	5	4	14	23
II	4	3	19	26
III	1	5	27	33
IV	4	1	8	13
Total	14	13	68	95

duction sold in this manner in Louisiana is very small. The planting seed sales of the majority of the growers consist mainly of cottonseed left after planting their own crop.

TIME AND PLACE OF SALE

Eighty per cent of the cottonseed sold to the ginner was sold at the time the farmer ginned his cotton, 4 per cent was carried home and sold to the ginner at a later date and 16 per cent was left at the gin and sold at the end of the season (Table VI). As a general rule growers operating small farms sell their cottonseed at the time their cotton is ginned. On the other hand, growers operating the large farms frequently make arrangements with the ginner to make settlements for their cottonseed at certain intervals or at the end of the season. Due to competition between gins, the large producers can bargain with the ginner on the basis of their volume of ginnings and frequently obtain a premium over the posted price.

Table VI. TIME OF SALE AND PERCENTAGE OF COTTONSEED SOLD TO GINNER BY FARMERS, LOUISIANA, 1943-44

DISTRICT	REPORTED BY FARMERS				
	Farmers reporting	Percentage of Cottonseed Sold			Percentage sold to ginner
		As ginned	Out of storage	At end of season	
	Number	Per cent			Per cent
I	23	88.7	8.1	3.2	83.6
II	26	71.8	1.9	26.3	81.2
III	33	70.1	0.7	29.2	91.0
IV	13	100.0	0.0	0.3	93.3
Total	95	79.8	4.0	16.2	86.9

Eighty-six per cent of the farmers surveyed paid their gin charges with a portion of their cottonseed; the remaining 14 per cent either sold their cottonseed for cash or exchanged it for cottonseed meal and hulls at the gin. The general procedure followed is for the ginner to deduct the ginning charges from the total amount to be paid for the cottonseed and to pay the difference in cash.

Growers selling their cottonseed direct to the cottonseed oil mill and to other dealers are principally those living in or near the community in which the oil mill is located and who were not able to secure cottonseed meal and hulls from the gin at which they ginned their cotton.

The growers deliver their cottonseed to the mill and receive the cottonseed meal and hulls in exchange for it. A small portion of the cottonseed was sold by the growers to ginners who had not handled their cotton.

PRICES RECEIVED BY FARMERS FOR COTTONSEED

With the beginning of World War II, the War Production Board directed the Commodity Credit Corporation to inaugurate a program designed to secure cottonseed oil and linters for war purposes. The Corporation entered into contracts with cottonseed oil mills, under which the mills agreed to purchase all available cottonseed on the basis of the United States Standard Grades, paying a minimum price per ton for seed of the "basis" grade, with premiums and discounts for seed of other grades, according to the standards. The sampling and grading of the cottonseed was under the supervision of the Agricultural Marketing Administration. Under the program for the 1943-44 season, the War Food Administration established a minimum support price for cottonseed at $56 per ton for "basis" grade cottonseed in all producing states except Oklahoma, Texas and New Mexico where the price was $55 per ton. Seventeen oil mills in Louisiana accepted the offer made by the War Food Administration and, complying with the agreement, purchased all cottonseed of the 1943-44 crop on the basis of the United States Standard Grades and paid $56 per ton for "basis" grade cottonseed with premiums and discounts for seed of other grades. The only variations in the prices paid by the oil mills for cottonseed were those caused by variations in the grade of seed purchased.

Under normal conditions, cottonseed prices are determined by the market value of the products produced from the seed. The price paid by processors of cottonseed is based on the present and anticipated value of the products to be obtained from the seed, less processing and transportation costs. The margins taken above costs of processing depend somewhat upon the price paid for seed by competitors in their respective territories. Ginners in turn base the prices which they pay growers for cottonseed on a margin per ton under the prices at which they can sell the seed to mills, and on what competing ginners pay for cottonseed.[2]

Crushing mills turn out four products. Crude cottonseed oil, the most valuable product, and linters are sold as semi-finished products. Cottonseed cake or meal, the second most valuable product, and cottonseed hulls are sold as finished products. Cottonseed oil competes with imported oils, tallow, whale oil, palm oil, and domestic animal and vegetable oils. Cottonseed cake and meal compete with other types of livestock feed; cottonseed hulls compete with roughage feeds, such as hay, silage, etc.; and cottonseed linters compete with cotton mill waste and wood pulp. This competition among the various substitutable materials determines the market value of these products.[3]

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[2] A. M. Dickson, *Cottonseed Prices in the United States, 1934-35,* (Washington, United States Department of Agriculture, Agricultural Adjustment Administration, March, 1936), p. 5.

Crushers cannot completely hedge their purchases of seed nor the equivalent value in products, and therefore the crushing business has an element of uncertainty. Anticipation on the part of the crushers as to whether the value of any one, or all, of the products will rise or fall may influence the prices paid by mills for cottonseed.

The quantity of products and the proportions of the various products milled from a ton of cottonseed are determined largely by the quality of seed. A larger proportion of the more valuable products can be milled from high quality cottonseed. Variations in the quantities of products obtained per ton of seed crushed by mills in Louisiana during the period 1928-43 are shown in Table VII. The price paid for cottonseed by the crushers may be influenced to some extent by the quality of the cottonseed purchased.

VARIATIONS IN COTTONSEED GRADES

The grades of cottonseed vary considerably during the year, the highest grades usually being obtained during the months of August and September and lower grades during the latter part of the season. There is considerable variance also in the grades of cottonseed between districts within the State and between communities within the individual parishes (Table VIII).

Variations in cottonseed grades are caused by several factors, such as atmospheric humidity, rainfall, sunshine, and soil moisture. High atmospheric humidity increases the free fatty acids in the oil in the seed which lowers the quality and grade of the cottonseed.[4] The lower grades obtained in District IV are attributable largely to high humidity. Extended periods of dry weather sometimes result in half filled seeds. Districts I and II are affected to a greater extent by this factor than Districts III and IV. Other factors affecting the oil and protein content of the cottonseed are the amount and time of defoliation and time of the first killing frost. The ammonia content of the seed is mainly determined by the soil moisture.[5] There are also indications that the variety of cotton and the types of soil in which the cotton is grown may influence the quality and grade of the cottonseed produced.

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[3] J. I. Morgan, "Cottonseed Crushing Industry," *Manufacturers Record,* CV, (1936), I, p. 23.

[4] G. S. Meloy, "Part of Address Given at the 48th Annual Convention of the National Cottonseed Products Association in New Orleans, Louisiana, May 17-18, 1944," *The Relation of Atmospheric Humidity to Free Fatty Acids* (Washington, War Food Administration, Office of Distribution, 1944).

[5] G. S. Meloy, *Relation of the Ammonia Content of Cottonseed to the Quantity and Quality of Cake Produced* (Washington, United States Department of Agriculture, Agricultural Marketing Service), p. 3.

Table VII. QUANTITY OF PRODUCTS OBTAINED PER TON OF COTTONSEED CRUSHED, LOUISIANA, 1928-43

DATE*	POUNDS OF PRODUCTS OBTAINED PER TON OF COTTONSEED CRUSHED					
	Total	Crude oil	Cake & meal	Hulls	Linters	Mfg. loss
1928	1874	321	869	575	109	126
1929	1881	320	886	544	131	119
1930	1899	315	916	542	126	101
1931	1865	299	869	585	112	135
1932	1885	322	871	586	106	115
1933	1886	314	890	572	110	114
1934	1876	322	852	572	130	124
1935	1854	311	881	516	146	146
1936	1895	307	892	554	142	105
1937	1881	302	875	544	160	119
1938	1828	308	865	521	134	172
1939	1891	321	892	530	148	109
1940	1884	347	845	516	176	116
1941	1856	313	859	511	173	144
1942	1841	316	870	475	180	159
1943	1868	307	963	428	170	152
Average	1873	315	881	536	141	127

* Year beginning August 1.
SOURCE: Bureau of Census, *Cotton Production and Distribution,* Bulletins 164-181.

The ginners sell their seed on the basis of its grade; but at present no economical method has been developed by which the small wagon lots of cottonseed purchased by the ginner from the grower can be graded. Although the grower seldom receives a premium or a discount for the various grades of cottonseed sold to the ginner, he may be benefited indirectly by the grading system. As shown in Table IX, the average price received by farmers was highest in Districts I and III which also had the highest average cottonseed grades. This indicates that in districts where growers produce a high quality of seed, upon which the ginner receives a premium, the premiums are reflected back to the growers in the form of a higher farm price.

PRICE MARGINS

The spread between the price received by farmers and the value of the products produced per ton of cottonseed is important to farmers in considering whether they might carry the productive process nearer to the consumer. Since there is little carry-over of cottonseed from one season to the next, the annual margin can be calculated from the seasonal mill-product values as reported by the Bureau of the Census and the average prices received by farmers as reported by the Bureau of Agricultural Economics. These annual margins are shown in Table X, together with the percentage of mill value attributed to each of the four

Table VIII. WEIGHTED AVERAGE SEED GRADES REPORTED BY GINNERS, LOUISIANA, 1943-44

DISTRICT AND PARISH	Gins reporting	GRADES BY MONTHS								Year average
		August	September	October	November	December	January	February	March	
		Basic grade equals 100								
DISTRICT I										
Bossier	1	104.0	105.5	104.0	101.5	101.0	*	*	*	104.0
Caddo	5	105.5	104.5	104.0	101.5	99.0	102.0	*	*	103.5
DeSoto	1	103.5	104.5	105.5	104.0	104.0	*	*	*	104.5
Natchitoches	2	102.0	102.5	95.5	78.5	*	*	*	*	97.0
Average	9	104.5	104.0	101.0	98.0	102.5	102.0	*	*	102.0
DISTRICT II										
Union	1	104.5	101.5	101.5	98.5	97.0	99.0	97.5	101.0	100.0
Lincoln	1	*	103.0	101.0	100.0	101.0	*	*	*	101.5
Average	2	104.5	102.0	101.5	99.0	97.5	99.0	97.5	101.0	100.5
DISTRICT III										
West Carroll	1	102.5	99.5	98.0	99.5	96.5	*	*	*	99.5
Caldwell	1	*	101.5	100.0	95.0	*	*	*	*	100.0
Franklin	1	104.5	103.0	98.5	100.0	90.0	97.0	74.0	*	102.5
Richland	1	106.0	104.5	102.0	95.5	90.5	*	*	*	102.5
East Carroll	1	109.5	109.0	108.0	114.0	84.0	*	*	*	109.0
Tensas	1	103.0	107.0	102.0	93.0	72.5	*	*	*	98.5
Madison	2	111.5	110.0	105.5	102.5	100.5	94.5	40.5	*	106.5
Concordia	1	111.5	110.0	93.0	100.0	62.5	*	*	*	97.5
Average	9	102.0	106.5	101.0	98.0	83.5	95.5	53.5	*	102.0
DISTRICT IV										
Pointe Coupee	1	105.5	99.5	62.5	30.5	*	*	*	*	87.5
Evangeline	3	93.5	99.0	84.0	59.0	87.5	*	*	*	93.0
St. Landry	2	98.5	102.0	88.0	78.0	*	*	*	*	99.0
Avoyelles	2	101.0	105.0	92.5	71.0	*	*	*	*	99.5
Vermilion	1	90.0	93.0	86.0	57.5	*	*	*	*	89.0
Lafayette	1	98.0	102.0	92.0	*	*	*	*	*	98.5
Average	10	96.5	101.0	83.0	59.5	89.0	*	*	*	95.5
State average	30	100.0	104.5	97.5	96.0	92.5	99.0	86.5	101.0	100.0

*No grades reported.

Table IX. WEIGHTED AVERAGE SEED GRADES AND AVERAGE PRICES PAID BY GINNERS, LOUISIANA, 1943-44

DISTRICT	REPORTED BY GINNERS	
	Average grade of cottonseed	Average price paid at gin
	Grade*	Dollars
I	102.0	54.56
II	100.5	53.00
III	102.0	54.13
IV	95.5	47.26
Total	100.0	52.84

*Basis grade = 100.

cottonseed products. Figure 2 shows the trend in product value, farm value, actual margins, and farm value as a percentage of mill value, by seasons. Both the value of products and the farm price per ton of seed show a considerable increase since 1940. The farm prices as a percentage of the product value has increased from 52.8 per cent in 1940 to 71.9 per cent in 1943. The margin between the farm price and mill product value per ton has varied from $9.36 in 1932 to $21.36 in 1942.

The middlemen's charges and the marketing margins have been relatively stable compared with the farm price and value of the cottonseed products. Due to the stability of marketing margins, the fluctuations in the farm prices are somewhat wider than those in the mill-product values. The oil mill margins vary with individual mills depending upon the volume of seed handled and distance seed is shipped to the mill. Relatively small mills obtain their supply of seed from gins located in the vicinity of the mill. Transportation costs in obtaining the seed are comparatively low as the average hauling distance is only about 25 miles. They operate for a relatively short season and normally sell the larger part of their production of meal and hulls to local consumers.

The practice of buying cottonseed on the basis of F. O. B. mill prices enables the larger mills to buy seed over wide areas and to compete for seed supplies with the small local mill. The transportation costs of the larger mills are comparatively high and the large territories served necessitate the use of a number of seed buyers to contact ginners to obtain their patronage. On the other hand, these mills usually operate for a more extended season, resulting in a more complete use of their capacity and lower processing costs.[6]

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[6] A. M. Dickson, *Cottonseed Prices in the United States, 1934-35* (Washington, United States Department of Agriculture, Agricultural Adjustment Administration, March, 1936), p. 16.

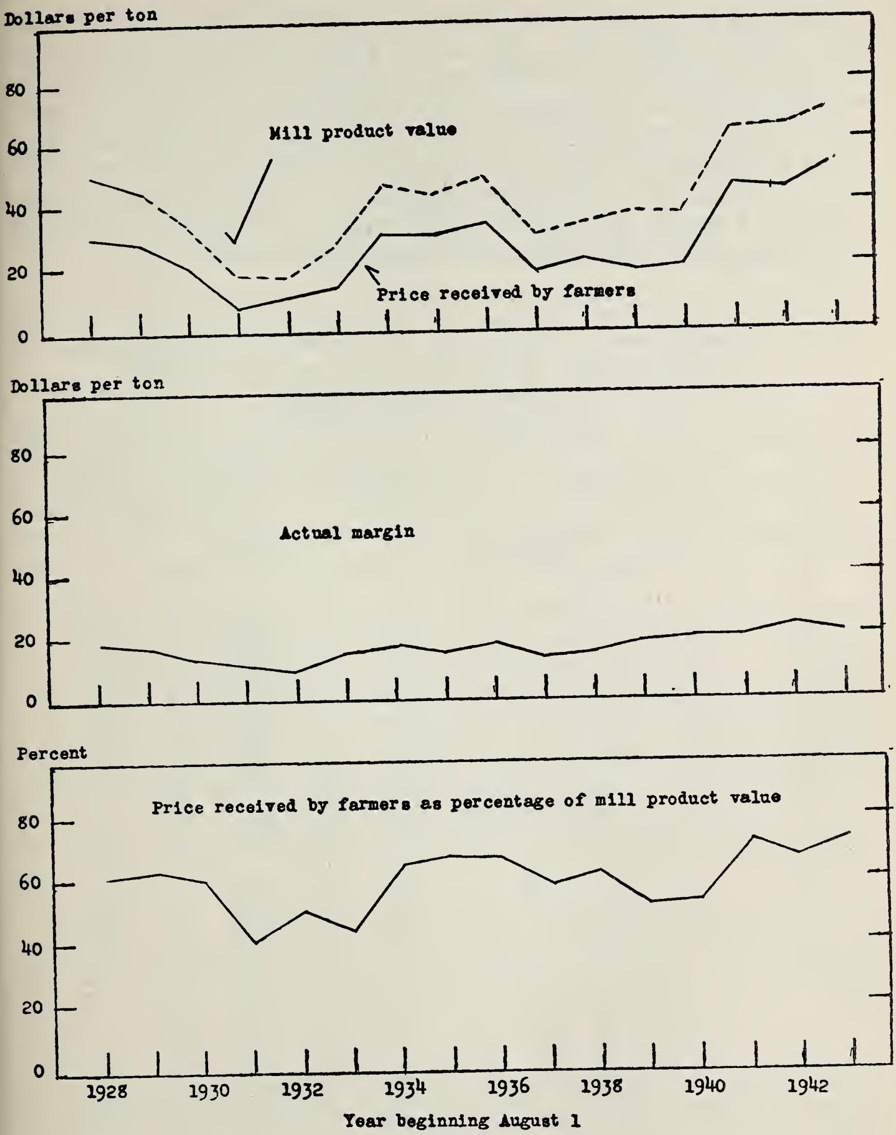
Table X. SEASONAL AVERAGE VALUE OF COTTONSEED PRODUCTS PRODUCED PER TON OF SEED CRUSHED, PERCENTAGE OF VALUE ATTRIBUTED TO EACH OF THE FOUR PRODUCTS, FARM PRICE OF COTTONSEED, AND MARGIN BETWEEN FARM PRICE AND PRODUCT VALUE, LOUISIANA, 1928-1943

YEAR*	Value of products per ton of seed	Farm price per ton	Actual margin†	Farm price as percentage of product value	Percentage of product value attributed to			
					Crude oil	Cake and meal	Hulls	Linters
	Dollars	Dollars	Dollars	Per cent	Per cent	Per cent	Per cent	Per cent
1928	51.22	31.76	19.46	62.0	52.3	32.6	4.5	10.6
1929	46.51	29.60	16.91	63.6	51.1	35.3	4.8	8.8
1930	34.50	21.28	13.22	61.7	54.2	33.8	6.5	5.5
1931	18.87	7.67	11.20	40.6	59.6	29.4	4.8	6.2
1932	19.47	10.11	9.36	51.9	54.6	31.9	6.1	7.4
1933	27.58	12.20	15.38	44.2	46.2	30.3	7.9	15.6
1934	48.61	31.78	16.83	65.4	49.3	31.1	6.3	13.3
1935	44.41	30.35	14.06	68.3	61.2	21.5	4.6	12.7
1936	49.91	33.77	16.14	67.7	54.3	27.3	4.8	13.6
1937	31.53	18.79	12.74	59.6	59.0	28.5	4.9	7.6
1938	33.43	20.58	12.85	61.6	57.8	28.6	5.9	7.7
1939	37.00	19.24	17.76	52.0	49.6	32.7	5.9	11.8
1940	38.46	20.32	18.14	52.8	48.8	28.4	6.4	16.4
1941	65.80	47.54	18.26	72.2	58.5	25.1	4.1	12.3
1942	65.80	44.44	21.36	67.5	60.5	23.9	3.4	12.2
1943	71.76	51.60	20.16	71.9	53.4	32.5	3.9	10.2

*Year beginning August 1. †Includes mill margin, transportation to mill and ginner's charges for selling seed.

SOURCES: Bureau of Census, *Cotton Production and Distribution*, Bulletins 164-181; Bureau of Agricultural Economics, *Farm Production, Farm Disposition and Value of Cotton and Cottonseed and Related Data, 1928-42.* June 1944.

Figure 2. - Cottonseed: Average Value of Products Per Ton of Seed Crushed, Price Received by Farmers and Margins, Louisiana, Annually, 1928-1943



Both small and large mills have lowered their conversion costs per ton for cottonseed by using their idle capacity between seasons to crush soybeans, peanuts and other oil bearing crops. They have also extended the period of operation by the addition of such operations as the mixing of fertilizers and feeds and handling other commodities made from the cottonseed products.

The size of margins taken by gins during the 1943-44 season varied considerably (Table XI). The wide variations are to a large extent the result of differences in trade practices used in arriving at the weights of the cottonseed. During the season one gin in District IV sustained an average loss in cottonseed weights of 303 pounds per ton and paid prices for cottonseed $8.40 lower than the price paid by the mill to which the seed were sold. Another gin in District I sustained an average loss of only 8.4 pounds per ton and paid prices for cottonseed only $2.13 below that paid by the mill to which the seed were sold.

Table XI. AVERAGE PRICE PAID FARMERS FOR COTTONSEED, AVERAGE PRICE RECEIVED BY GINNERS AND MARGIN BETWEEN FARM PRICE AND PRICE RECEIVED BY GINNERS, LOUISIANA, 1943-44*

LOCATION OF GINS REPORTING		Average price per ton received by ginner	Average price per ton paid farmers	Gin margin per ton
Parish	District	Dollars		
Bossier	I	58.13	56.00	2.13
Caddo		57.39	57.39	0.00
Caddo		58.30	53.37	4.93
Caddo		56.96	49.84	7.12
Caddo		56.90	57.59	−0.69
Caddo		58.73	55.34	3.39
DeSoto		58.41	52.35	6.06
Natchitoches		52.84	53.00	−0.16
Natchitoches		56.59	53.00	3.59
Union	II	56.04	53.00	3.04
Lincoln		56.77	53.00	3.77
West Carroll	III	55.88	53.88	1.70
Caldwell		56.13	53.42	2.71
Richland		57.52	52.51	5.01
East Carroll		60.98	55.00	5.98
Madison		60.21	53.70	6.51
Madison		59.37	59.14	0.23
Concordia		54.66	52.16	2.50
Pointe Coupee	IV	49.09	46.09	3.00
Evangeline		53.19	46.38	6.81
St. Landry		52.50	46.98	5.52
Avoyelles		55.80	52.04	3.76
Lafayette		55.07	46.67	8.40
Average		56.49	52.84	3.65

*Survey data.

METHODS USED TO DETERMINE WEIGHT OF COTTONSEED

Five different methods of calculating the weight of cottonseed were used by ginners interviewed (Table XII). Method I: Twenty-five ginners obtained the weight of the cottonseed by deducting the gross weight of the lint bale from the weight of the seed cotton. Both the gross weight of the lint bale and the weight of the seed cotton were determined by the use of scales. In using this method, ginners assume that the weight of the bagging and ties is sufficient to make up for the loss in weight due to trash and moisture removed during the ginning process.[7] There is a considerable range in the weights of cottonseed as obtained by various ginners using this method, caused largely by variations in the amounts of trash and moisture removed during ginning. The gin weights of cottonseed as compared with the oil mill weights ranged from a gain of 22.5 to a loss of 156.8 pounds per ton with an average loss of 49.2 pounds (Table XIII).

Method II: Five ginners obtained cottonseed weights by a method similar to the one described above, except that a fixed deduction was taken from the weight obtained as an adjustment for loss of trash and moisture during the ginning process. The deductions taken by the ginners ranged from 5 to 10 per cent of the weight obtained. Weight losses at the mill sustained by ginners using this method ranged from 90.5 to 195.4 pounds and averaged 128.6 pounds per ton.[8]

Method III: Two ginners calculated the weight of the cottonseed by deducting a specified amount from the gross weight of the lint bale and doubling the difference. The deduction taken by the ginners ranged from 20 to 25 pounds per bale. The gross weight of the lint bale is determined by scales and is the only actual weight used in the calculation. The cottonseed weight is determined upon the basis that the cottonseed and lint are produced in a ratio of two to one and the deduction is made to allow for losses during the ginning process. Ginners using this method sustained a loss of 167.2 pounds per ton of seed when their weights were compared with the weights received at the oil mill.

Method IV: Three ginners obtained cottonseed weights similar to Method III, except that the gross weight of the lint bale is doubled first and then the deduction is taken. The deductions taken by the ginners ranged from 15 to 20 per cent of the weight obtained. Ginners sustained a loss of 227.6 pounds per ton in using this method.

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[7] The gross weight of the lint bale includes the weight of the bagging and ties with which the bale is wrapped. Twenty-two pounds for jute bagging and fourteen pounds for cotton bagging are the commonly accepted weights of bagging and ties.

[8] Three of the five gins using this method were located in District IV. Due to the rank growth of cotton and high atmospheric humidity, the losses of weight due to trash and moisture removed during ginning are much larger in District IV than in Districts I, II, and III. Although a deduction is made to adjust for these losses, the loss in weight at the oil mill sustained by these ginners was greater than that of gins using the same method of weight calculation, but making no deductions for trash and moisture loss.

Table XII. Methods Used by Ginners to Calculate the Weight of Cottonseed Bought, Louisiana, 1943-44

District	Method of calculating cottonseed weight at gin as reported by ginners						Total
	Seed cotton less gross weight of bale (1)	Seed cotton less gross weight of bale—less discount for trash (2)	Gross weight of bale less deduction for trash-doubled (3)	Double gross weight of bale —less discount for trash (4)	Cottonseed scales—actual weight of seed (5)	Other*	
	Number of gins						
I	8	0	0	0	6	1	15
II	1	1	0	0	4	0	6
III	13	1	0	0	1	0	15
IV	3	3	2	3	2	0	13
Total	25	5	2	3	13	1	49

*Plantation gin—no weight calculated.

Method V: Thirteen ginners used scales to determine the actual weight of the cottonseed purchased. Ginners using scales sustained a loss of only 9.2 pounds per ton when their weights were compared with those at the oil mill. This amount represents the loss in weight per ton which can be expected to result from moisture evaporation and seed handling during shipment to the oil mill.

Table XIII. Comparison of the Cottonseed Weights as Calculated at the Gin with Those Obtained at the Oil Mill, Louisiana, 1943-44

Method of calculating cottonseed weights at the gin	Comparison of gin weights to oil mill weights		
	Ginners reporting	Average loss in weight per ton	Average loss in weight per ton due to miscalculation*
	Number	Pounds	Pounds
1. Seed cotton less gross weight of bale	18	49.2	40.0
2. Seed cotton less gross weight of bale—less deduction for trash	4	128.6	119.4
3. Gross weight of bale—less deduction for trash doubled	2	167.2	158.0
4. Double gross weight of bale—less deduction for trash	3	227.6	218.4
5. Cottonseed scales—actual weight of cottonseed	12	9.2	0.0

* Weight loss sustained when seed scales are used was assumed to represent loss in weight due to handling and shipping of seed from gin to oil mill, and was deducted from total to obtain loss due to miscalculation of cottonseed weights by use of other methods.

OTHER TRADE PRACTICES AFFECTING THE GINNERS' PRICE MARGINS ON COTTONSEED

First, the ginners' margin on cottonseed varies according to the price paid for cotton. Ginners sometimes pay more for the cotton lint than they can sell it for at the time of purchase and then recoup their losses by paying lower prices for cottonseed. Eight out of 13 ginners in District IV reported buying both lint cotton and cottonseed from the growers. In the other three districts only one other ginner reported buying a limited amount of lint cotton, and he was located in District I (Table XIV). A gin in District IV buying both cotton and cottonseed paid an average of $6.81 per ton lower than the price received for the cottonseed. Another gin in the district which did not buy cotton paid an average of $5.52 per ton lower than the price received.

Table XIV. GINNERS BUYING LINT COTTON AT THE GIN, LOUISIANA, 1943-44

DISTRICT	No. gins reporting	Average No. bales ginned per gin	Average No. bales lint bought by gin*	No. gins buying lint cotton
I	15	1,869	75.0	1
II	6	1,686	0	0
III	15	2,020	0	0
IV	13	1,271	550.0	8
Total	49	1,734	169.00	9

*Does not include remnant bales bought by ginner.

Second, the ginners' margin varies with the method used in making settlements with growers for their cottonseed. A ginner making settlements for seed purchased on the basis of the grade analysis of the seed can operate on a smaller margin than a ginner who makes settlements on an estimation of what the grade analysis will be. The latter is a form of speculation and necessarily involves a greater risk. Forty-two ginners paid the growers for cottonseed on the basis of a posted gin price (Table XV). Two ginners paid growers for cottonseed on the basis of the posted gin price, making additional payments to large growers as an incentive to retain their future patronage and in order to obtain as large a volume of business as possible. Four ginners in addition to purchasing a portion of their seed on the basis of the posted gin price, also purchased a portion on the basis of the average seed grade analysis as received from the cottonseed oil mill. Only one ginnner reported that he bought all cottonseed from growers on the basis of the grade analysis of the seed.

Third, margins may vary according to how fully the prices the ginners pay for cottonseed reflect the premiums or discounts which the ginner receives from the oil mill. The margins at the beginning of the season, when seed are low in grade, are often very small; but during the peak of the season when premiums are received, the margin may be much larger.[9]

Fourth, where ginners charge lower than average prices for ginning, they frequently take rather large margins for handling cottonseed. Ginning charges were found to be higher in District IV than in the other districts, but the gin margins on cottonseed after allowances were made for seed weight losses were comparatively small.

Fifth, the wide variations in the margins taken by gins for handling cottonseed may be influenced by the degree of competition between gins. In other words, in places where there is little competition in ginning cotton and buying cottonseed, the ginners generally pay lower prices for cottonseed than they do in places where competition is keen.[10]

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[9] A. M. Dickson, *Cottonseed Prices in the United States, 1934-35* (Washington, United States Department of Agriculture, Agricultural Adjustment Administration, March, 1936), p. 88.

Table XV. METHOD USED BY GINNERS IN MAKING SETTLEMENTS FOR COTTONSEED PURCHASED, LOUISIANA, 1943-44

DISTRICT	METHODS OF MAKING SEED SETTLEMENTS AS REPORTED BY GINNERS				Gins reporting
	On basis of posted gin price	On basis of posted price with additional payments to large growers	On basis of posted price also on grade analysis	On basis of seed grade analysis	
	Number				
I	12	1	2	0	15
II	6	0	0	0	6
III	12	1	2	0	15
IV	12	0	0	1	13
Total	42	2	4	1	49

HOW PRICE MARGINS MIGHT BE REDUCED

The average margin between the value of products obtained per ton of seed crushed and the price received by farmers for cottonseed for Louisiana as a whole was $20.16 per ton for the 1943-44 season, $21.36 per ton for the 1942-43 season, and $18.26 for the 1941-42 season (Table X). These margins cover costs of assembling, transporting and processing cottonseed, and the profits of middlemen and the oil mills. Data showing the relation of margins taken to necessary costs are not readily available and therefore further study of the question of more efficient operation of oil mills would be desirable.

One cooperatively owned cottonseed oil mill operated in Louisiana in 1944. It is called the St. Landry Soybean Cooperative and is located at Washington, Louisiana. The mill processes cottonseed, soybeans and during the summer of 1943, it crushed 919 tons of imported babassu nuts for the Commodity Credit Corporation on a contract and then purchased and resold the meal. Some published data with regard to the costs and surpluses experienced by this cooperative oil mill may be of suggestive value. The operating results per ton of cottonseed as estimated by the Association, based on a 70-day operation, were as follows:

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[10] A. M. Dickson, *Cottonseed Prices in the United States, 1934-35* (Washington, United States Department of Agriculture, Agricultural Adjustment Administration, March, 1936), p. 90.

Proceeds:		
Cottonseed oil—290 pounds @ 12$\frac{5}{8}$ cents per pound		$36.612
Cottonseed cake—1400 pounds @ $43.00 per ton		30.100
Mill linters—150 pounds @ 4.1 cents per pound		6.150
		$72.862
Less:		
Cost of seed	$59.00	
Hauling	1.70	$60.700
GROSS MARGIN		$12.162
Less operating expenses:		
Selling	$ .100	
Fuel	.650	
Plant labor	2.750	
Supplies—bags, etc.	3.250	
Overhead—including idle season	1.312	
Depreciation	.600	$ 8.662
NET MARGIN		$ 3.500

Source:

Lacey F. Richey, *Cooperative Feed Distribution in the New Orleans Farm Credit District* (Washington, United States Department of Agriculture, Farm Credit Administration, January 1945), Misc. Report No. 76, pp. 31-32.

The average expenses of the cooperative mill amounted to $10.36 per ton, including the transportation charges on seed from the members' local shipping points to the mill. On the basis of these average per ton expenses and on the assumption that spreads between value of products and farm price of cottonseed equal those for the State as a whole, a cooperative oil mill would have available for payment of interest on borrowed operating capital, dividends on the capital invested, and patronage dividends or refunds to members, an average of $9.80 per ton for the 1943-44 season. Assuming that the private gins, which gin cotton for the "would-be" farm members of a cooperative mill, retain a margin of $3.65,[11] the cooperative mill still would have $6.15 per ton available for interest, dividends, etc.

Price margins may also be reduced by the adoption of more uniform trade practices among the ginners within the State. As previously pointed out, the use of cottonseed scales to obtain the actual weights of cottonseed purchased will reduce considerably the loss in seed weight sustained by ginners and should make lower margins possible.

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[11] Average gin margin reported by ginners interviewed (Table XI).

SUMMARY AND CONCLUSIONS

1. Cottonseed, which less than sixty-five years ago was considered largely a by-product from the growth of cotton, is at present an important source of cash income to Louisiana farmers. Cottonseed ranked sixth in value among the major field crops grown in Louisiana during the 1943-44 season and accounted for about 18 per cent of the total value of the cotton crop. The cottonseed sold from the 1943-44 crop was worth nearly 14 million dollars.

2. During the 1943-44 season, farmers retained 7.2 per cent of their cottonseed for home use as planting seed, 2.4 per cent for home use as feed for livestock and for fertilizer and 3.3 per cent for sale as planting seed. The remainder of the crop, 87.1 per cent, was sold largely to the local ginners. Of the seed sold to the gin, 80 per cent was sold at the time of ginning, 4 per cent during the season and 16 per cent at the end of the season. The amount of cottonseed retained by farmers for home use changed very little during the 1943-44 season as compared with the 1942-43 season.

3. Normally the price paid by oil mills for cottonseed is based on the current and anticipated value of the products processed from the seed, less processing and transportation costs. The margins retained for processing are less liberal where competition is active. However, since 1942, mills have operated under contracts with the Commodity Credit Corporation and purchase all cottonseed on the basis of United States Standard Grades. The mills pay a minimum price per ton for seed of the base grade with premiums and discounts for seed of other grades. The minimum price in Louisiana during the 1943-44 season was $56.00 per ton for "basis grade" cottonseed.

4. Ginners in turn base the prices which they pay growers for cottonseed on a margin per ton under the prices at which they can sell the seed to the mills. The ginner margin varies somewhat with what competing ginners pay for cottonseed.

5. The grade of cottonseed depends largely upon the weather and soil conditions under which the seed are produced and was found to vary considerably. Cottonseed grades during the 1943-44 season ranged from 102 in District I to 95.5 in District IV. Although the individual farmer seldom receives premiums or discounts upon cottonseed sold, he may be benefited indirectly by the grading system. Ginners receiving premiums or discounts on seed sold generally reflect a portion of the gain or loss in the price paid for cottonseed at the gin.

6. The annual margins between the value of cottonseed products sold by the mill and the average price received by farmers were found

to be relatively stable as compared with the fluctuations in the annual value of the products and the average farm price. The fluctuations in the average farm price were somewhat wider than those for the mill product values.

7. The average margins per ton retained by ginners varied from —$0.69 to $8.40. Some of the causes of the wide variations in margins were: Use of arbitrary methods in arriving at weights of cottonseed; paying high prices for cotton and absorbing losses on profits from cottonseed; methods used in making seed settlements with growers; charging low prices for ginning services and taking wide margins on cottonseed; and the degree of competition between gins.

8. Results from the operation of a cooperative oil mill during the 1943-44 season in Louisiana suggest that cooperative processing might enable farmers to reduce the margin between the value of cottonseed products and the price received for raw cottonseed.

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RESPONSE OF SUGARCANE TO THE HOT-WATER TREATMENT

By

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* The authors are also indebted to others who have assisted in the investigations, including several graduate students, managers and owners of the plantations on which the tests have been located, and Dr. S. J. P. Chilton, who has assisted in preparing the manuscript and in compiling the tables in the appendix.

THE HOT-WATER TREATMENT OF SUGARCANE

The investigations on the hot-water treatment of sugarcane reported in this bulletin represent the work during a period of years of various members of the Department of Plant Pathology of the Louisiana Agricultural Experiment Station and the Department of Botany of Louisiana State University with the assistance of several graduate students who were interested in sugarcane problems. It was inaugurated by request of the Contact Committee of the American Sugar Cane League at the time the chlorotic streak seemed to be spreading over the Sugar Belt of the State.

Investigations in other sugar-producing countries, especially in Australia and Hawaii, had shown that submerging the seed cane in hot water at a temperature of 52°C. (125.6°F.) for 20 minutes would completely eradicate the chlorotic streak from the stalks and it seemed important to find out whether or not such a treatment would be effective and practical under Louisiana conditions. The hot-water treatment stimulates the germination of the buds and the growth of the young shoots and there was no assurance at the time that this stimulation would be advantageous in Louisiana. In the tropics, the buds on the seed pieces germinate immediately after planting and the stimulation which comes from the hot-water treatment usually insures better stands in the field. In Louisiana, on the other hand, the cane remains in the soil for 2 to 4 months during the winter season in a more or less inactive condition. There was a possibility that excessive germination of the buds on the seed cane in the fall, followed by the killing of the young shoots by the winter freezes, might, in some years, result in poor stands the following spring. Before the hot-water treatment could be recommended for Louisiana, it was necessary to conduct tests through a period of years in order to find out what effect it would have on the seed cane.

Such tests have now been made. These have included preliminary tests to determine whether or not the hot-water treatment was effective in eradicating the chlorotic streak from the stalks and a series of large scale tests in various parts of the state running through a period of five years to determine the effect of the treatment on the germination of the buds and on yields.

Results of the investigations have been published from time to time in progress reports, in a bulletin (Louisiana Bulletin 336. 1942) and in the reports to the Contact Committee of the American Sugar Cane League in *The Sugar Bulletin.* In the present bulletin, however, all of the information and data have been brought together. As the data are extensive, it has seemed best to place them in tabular form at the end of the bulletin in an appendix, separate from the main part of the bulletin. In these tables, any one may obtain detailed information of the results with the different varieties on the various plantations.

EFFECT OF TREATMENT ON CHLOROTIC STREAK

Tests made in Australia and Hawaii indicated that the chlorotic streak could be entirely eliminated from cane stalks by the hot-water treatment. To determine if similar results could be expected in Louisiana, small-scale tests were made on Lower Terrebonne Plantation at Montegut in 1939 and 1940. Three varieties, C.P.29/320, C.P.28/19 and C.P. 807 were included. Plots were planted with treated and untreated healthy cane and treated and untreated stalks that were known to be infected with chlorotic streak. In all tests, the treated cane germinated better than the untreated cane. The chlorotic streak infected cane that was treated produced stands almost as good as the disease-free cane and the shoots from this cane showed no symptoms of the disease. On the other hand, cane infected with chlorotic streak which was not treated showed a lower germination than the disease-free cane and from 25 to 95 per cent of the shoots that developed showed the streaks characteristic of the disease. These tests showed conclusively that the hot-water treatment would eliminate the chlorotic streak in the stalks and further tests did not seem necessary.

METHODS USED IN PLANTATION TESTS

To determine the effect of the hot-water treatment on germination of the buds of sugarcane and on the yield of cane during five consecutive years large scale tests were made on nine plantations. These plantations were selected as being typical of the various areas in the Sugar Belt. The plantation owners or managers cooperated in the work and besides caring for the plots, assisted in the treating, planting and harvesting operations. The plantations on which the tests were made were as follows:

Cooperator	*Plantation*	*Locality*	*Parish*
Delgado-Albania Plantation	Albania	Jeanerette	St. Mary
Billeaud Sugar Factory	Billeaud	Broussard	Lafayette
Estate Harry L. Laws	Cinclare	Cinclare	W. Baton Rouge
Bronier Thibaut	Glenwood	Napoleonville	Assumption
Realty Operators, Inc.	Greenwood	Thibodaux	Lafourche
South Coast Company	Lower Terrebonne	Montegut	Terrebonne
Meeker Sugar Refining Co.	Meeker	Meeker	Rapides
Godchaux Sugars Inc.	Raceland	Raceland	Lafourche
Milliken & Farwell	Westover	Port Allen	W. Baton Rouge

In all of the tests, plots planted with untreated seed cane were compared with plots planted with seed cane that had been given the hot-water treatment. On each plantation, four plantings were made each year, these being made as near the first of the months of August, September, October and November as was possible. Two varieties were used in each planting. Each test consisted of four sets which were randomized. For each planting, then, with only a few exceptions, there were four untreated and four treated plots of each variety. The plots were mostly 1/80 acre.

Considering all of the tests, eight varieties were used: C.P.29/320, C.P. 28/19, C.P. 29/103, Co. 281, Co. 290, C.P. 34/120, C.P. 29/116 and C.P.29/120. Except for a few tests on Billeaud Plantation, C.P.29/320 was used as one of the varieties in all of the tests. The variety C.P.28/19 was used in tests for four years on six plantations. The other varieties were selected because of their popularity in local areas.

The treatment consisted of submerging the seed cane in water at 52°C. for 20 minutes. With one exception only healthy cane was used. The treating procedures as a whole were similar on all plantations. Tanks were used, each being approximately 4 X 10 X 5 feet, with steam jets in the bottom at each end. The steam was furnished largely by sugar-house boilers. An electric, gas or steam pump kept the water in circulation during the treating process. The cane to be treated was placed in screen baskets and placed in the tanks by means of the regular hoists used in unloading cane. Since the cane had a cooling effect, the water in the tank was usually raised to about 53°C. before the cane was placed in it. If the temperature of the water dropped below 52°C., it was immediately brought back to 52°C. with steam through the steam jets. The temperature of the water was held at 52°C. for 20 minutes and the water was kept in motion to insure an even temperature. After 20 minutes, the cane was removed and taken to the field for planting. In most cases, the cane was planted immediately.

None of the plots received special attention. The plots were planted, cultivated and fertilized according to the regular practice on the plantation. In all tests, two running stalks were planted with a lap of 12 to 18 inches.

Germination and stand counts were usually made at appropriate times in the fall and spring.

At harvest time, each plot was cut by hand and the weight of cane obtained. The cane from the 1940-41 crop was stripped clean of leaves and trash when cut. In later years, due to the labor shortage, in some cases the cane was merely topped. The cane from each plot was weighed by means of a portable dial-scale weighing apparatus.

During the first two years, the cane was analyzed either by chemists of the various plantations or by chemists at Louisiana State University. The analyses were made from five-stalk samples and the values in the tables represent the averages of four such samples unless otherwise indicated. As significant differences were not found in the two years' work, it did not seem necessary to continue making the chemical tests.

FALL GERMINATION OF BUDS

The immediate effect of the hot-water treatment has been in most cases a stimulation of the buds on the seed pieces and this has usually resulted in a rapid production of young shoots shortly after planting. In the tests in Louisiana, this has been most noticeable in the September and October plantings. Usually a few weeks after planting, the rows in the treated plots have been well-marked with numerous green shoots in contrast to a much sparser development of shoots in the untreated plots. In the August plantings, this difference has not been so marked. In a few cases in the August plantings, the hot-water treatment has apparently caused a slight injury to the green, soft cane used for planting. This injury, however, was not extensive enough to materially reduce the stands obtained in the fields. In the November plantings, with the exception of one year, the winter temperature conditions which followed the planting prevented an immediate germination of the buds on the treated as well as on the untreated plots.

In order to determine definitely the effect of the hot-water treatment on the germination of the buds, counts of the number of shoots were made in the field on the various plots. Data for three years are available on the fall germination. In the first year, 1940-41, counts on the August, September and October plantings were made in December and on the November plantings in January. In the other years, the counts were made about 30 to 45 days after planting.

The results of the counts for C.P.29/320 are given in Table 1, for C.P.28/19 in Table 2 and for the other varieties in Table 3. In the September plantings with C.P.29/320 (Table 1), increases in germination due to the hot-water treatment occurred in 25 of the 26 tests with no difference in the other one, while in the October plantings there were significant increases in stand in all 26 tests. When all tests were averaged, it was found that the average number of shoots in the untreated plots in the September plantings was 363, compared with 562 in the treated plots. In the October plantings, there was an average of 188 shoots in the untreated plots and 337 in the treated. Similar increases in the fall germination also were obtained with the other varieties (Tables 2 and 3).

The rapid increase in the germination of the buds due to the hot-water treatment which has been observed in the Louisiana tests is very similar to that reported in other sugar-producing countries and there seems no doubt but that a stimulation is brought about by the treatment.

HOT-WATER TREATMENT INCREASES SPRING STANDS

A good stand of cane in the field in early spring is essential for a good yield of cane in the fall. Even in the best years, the growing season is not more than seven months and in many years it is even less. While it is true that plants usually sucker freely and will to a degree fill in short gaps in the row, it is also self-evident that plants ready to grow on the first of April will do better and produce more sugar in November than suckers which develop later in May or June. Consequently, it seemed very important to learn whether or not the hot-water treatment would affect in any way the stands in the early spring.

In practically all of the tests which were made during the five-year period, counts were made of the plants on each plot in the spring. Due to the fact that weather conditions which influenced shoot production varied from year to year and also to the fact that the time of making the counts varied from year to year, the results show considerable variations in the different years. In all years, however, it has been possible to compare the treated plots with the untreated.

The results of the spring counts for C.P.29/320 are given in Table 4, for C.P. 28/19 in Table 5 and for the other varieties in Table 6. The differences in stand between the treated and untreated plots in the August plantings were not significant but were very outstanding in the September, October and November plantings in which the treated plots showed on an average from 35 to 60 per cent more plants than the untreated. Averaging the results during five years, the untreated plots of C.P.29/320 showed in the September plantings 937 plants as compared to 1284 in the treated plots, in the October plantings 496 as compared to 780 and in the November plantings 372 as compared to 591. The counts on C.P.28/19 were similar to those on C.P.29/320. Based on a smaller number of tests, the hot-water treatment also gave better stands with Co. 281, C.P. 29/120 and C.P. 34/120. The results with Co. 290 and C.P. 29/116 were somewhat erratic and were not conclusive.

It seems apparent that with at least most of the commercial canes now being planted in Louisiana, better stands with cane planted from September to November can be obtained in the spring by treating the seed cane with hot water.

JUICE ANALYSES

To determine whether or not the hot-water treatment had any effect on the juice of the stalks grown from treated seed cane, the usual chemical analyses were made from two crops of plant cane and one of stubble. The results for C.P.29/320 are presented in Table 7, for C.P.28/19 in Table 8 and for the other varieties in Table 9. The sucrose seemed to be very slightly higher in the cane on the treated plots due perhaps to the fact that the cane had a slightly earlier start in these plots in the spring. The difference, however, did not seem large enough to be significant.

HOT-WATER TREATMENT INCREASES YIELDS

From the viewpoint of the sugar producer, the increase in the amount of cane harvested and sent to the mill is undoubtedly the most important criterion to be considered when any operation or change in method of production is being evaluated. In the tests with the hot-water treatment in Louisiana, all plots with the exception of a few on which mistakes were made in harvesting, were cut and the cane from each weighed. Results are available for tests made through five years on plant cane and for four years on the subsequent stubble crops. The results are included in the tables in the Appendix of this bulletin. In evaluating the data on a project as extensive as this one has been, a study should be made of the individual tests in order to have an idea of the variations that occur, but the most emphasis should be placed on the averages. In an examination of the tables, it will be found that the yields of a few of the treated plots were apparently too low and a few were apparently too high. It may be assumed that the few wide departures from the average were caused by some local soil condition or to some other unknown favorable or unfavorable condition.

The variety, C.P.29/320, was included in all tests with the exception of a few later ones on Billeaud Plantation. The data, then, on this variety are more extensive and consequently more reliable than with other varieties that were used in only a limited number of tests. Yields were obtained on the plant cane of this variety grown from treated and untreated seed cane for the five years and for four stubble crops of the succeeding years. Results with plant cane are presented in Table 10 and with stubble cane in Table 11.

The results on the August planted plots of C.P.29/320 in the first crop (plant cane) were somewhat erratic, varying from a decrease of 5.0 tons per acre on the treated plots at Greenwood to an increase of 3.0 tons at Billeaud plantation. The heavy decrease in the plots planted with treated cane at Greenwood was due to an almost complete failure of the treated plots in 1940-41. This failure was caused by a 10-inch rain which fell immediately after planting, packing the soil so hard that the young shoots could not emerge. The average yields, however, for all tests during the five years were identical for the plots planted with treated cane and with untreated cane, 26.0 tons per acre. There is some evidence that in some tests the hot-water treatment injured slightly the very tender buds of the green cane used in the August plantings. In all of the tests planted later, from September to November, material increases were obtained in the plots planted with treated cane. In the September plantings, increases in yields of the plots planted with treated cane over those with untreated cane varied from 0.9 tons at Greenwood to 7.4 tons at Meeker. The average yields for 38 tests on 9 plantations were 27.0 tons per acre for the untreated plots and 30.5 tons for the treated plots, an increase of 3.5 tons per acre. In the October tests, increases ranged from 1.2 tons at Billeaud to 4.3 tons at Meeker, the average yields for 39 tests being 25.7 tons for the untreated plots and 28.9 tons for the treated, an increase of 3.2 tons. In the November tests, increases ranged from 1.2 tons at Billeaud to 5.0 tons at Greenwood, the average yields for 35 tests being 24.0 tons for the untreated plots and 27.4 tons for the treated, an increase of 3.4 tons per acre.

The results from the first-year stubble crops of C.P.29/320 (Table 11) were as might be expected somewhat more erratic than the results from the plant cane. The yields of the stubble crops were apparently determined by the stands of plant cane of the preceding year and not by any direct effect of the hot water treatment. In general, however, the yields of stubble cane in the treated plots were somewhat greater than in the untreated plots. In the August plantings, the differences in yield of the stubble plots varied from a decrease of 2.5 tons in the treated plots at Greenwood to an increase of 4.2 tons at Billeaud, the average yields for 25 tests being 19.8 tons for the untreated plots and 20.3 tons for the treated, an increase of 0.5 tons per acre. In the September plantings, increases in yields of the treated plots ranged from 0.6 tons at Albania to 4.4 tons at Meeker, the average yields being 21.3 tons for the untreated plots and 23.2 tons for the treated, an increase of 1.9 tons per acre. In the October plantings, the differences in yields varied from a decrease of 2.2 tons on the treated plots at Billeaud to an increase of 4.0 tons at Westover, the average yields being 21.6 tons for the untreated plots and 23.2 tons for the treated, an increase of 1.6 tons per acre. In the November plantings, differences in yields on the treated plots ranged from a decrease of 0.2 tons at Glenwood to an increase of 7.1 tons at Greenwood, the average yields being 21.9 tons for the untreated plots and 23.7 tons for the treated, an increase of 1.8 tons per acre.

The variety, C.P.28/19, was included in tests on six plantations and so the data obtained are sufficient to be reliable. The results for plant cane are presented in Table 12 and for stubble cane in Table 13.

The results obtained with the plant cane of C.P.28/19 were quite similar to those obtained with the variety C.P. 29/320 though the increases in yield due the hot-water treatment were somewhat less. In the August plantings, the average yields in 21 tests were 26.2 tons per acre on the untreated plots and 26.1 tons on the treated, a decrease of 0.1 ton per acre. In the September plantings, the average yields in 22 tests were 26.1 tons on the untreated plots and 28.6 tons on the treated plots, an increase of 2.5 tons per acre. In the October plantings, the average yields in 22 tests were 24.5 tons on the untreated plots and 26.9 tons on the treated, an increase of 2.4 tons per acre. In the November plantings, the average yields in 20 tests were 23.6 tons on the untreated plots and 26.4 tons on the treated, an increase of 2.8 tons per acre.

The results obtained with the first year stubble crop of C.P. 28/19 were in general also similar to those obtained with the stubble crop of C.P. 29/320. The average yields in the August plantings of the stubble plots planted with untreated and treated cane were 19.1 and 19.3 tons, an increase in favor of the hot-water treatment of 0.2 tons; in the September plantings of 19.3 and 20.6 tons, an increase of 1.3 tons per acre; in the October plantings of 20.7 and 22.4 tons, an increase of 1.7 tons per acre; and in the November plantings of 20.1 and 21.8 tons, an increase of 1.7 tons per acre.

Six other varieties, Co. 281, Co. 290, C.P. 29/103, C.P. 29/116, C.P. 29/120 and C.P. 34/120 were included in some of the tests on certain plantations in one or more years. The data on these are presented in Table 14 to 19. While the data are too limited to permit definite conclusions, they are suggestive of the results which may be expected from the hot-water treatment with these varieties.

The variety, Co. 281, was included in the tests at Cinclare for four years (Table14). Average yields for the four years show increases in the plots planted with cane treated with hot water in the September, October and November plantings and a decrease in the August plantings. This variety, however, has been practically eliminated in most sections of the State and consequently further tests with it do not seem worth while.

The variety, Co. 290, was used for two years at Albania and one year at Billeaud (Table 15). While increases were obtained from the hot-water treatment, these were low when compared to those obtained with C.P. 29/320.

The variety, C.P. 29/103, was used for two years at Albania and for one year at Greenwood (Table 16). Increases of the plant cane due to the hot-water treatment were 1.1 tons, 2.1 tons, 5.7 tons and 6.6 tons in the August, September, October and November plantings, and increases of the stubble cane of 0.1 tons, 0.6 tons, 1.8 tons and 7.8 tons for the four plantings. These results seemed comparable to those obtained with C.P.29/320.

The variety, C.P. 29/116, was used in tests for three years (Table 17). While the results were erratic, the data indicate that the hot-water treatment injured the cane slightly and was responsible for slight decreases in yield.

The variety, C.P. 29/120, was used for two years at Billeaud (Table 18). Increases in yields due to the hot-water treatment were similar to those obtained with C.P. 29/320.

The variety, C.P. 34/120, was used on six plantations in 1944-45 (Table 19). Increases in yields due to the hot-water treatment of 0.1 tons, 1.9 tons, 1.6 tons and 3.5 tons were obtained for the August, September, October and November plantings, apparently placing this valuable variety in the class with C.P.29/320.

Costs of Treatment

The hot-water treatment of seed cane has not as yet become an established operation on any of the sugar plantations in Louisiana. Consequently, it is not possible to state what equipment would be the most economical and what would be the cost of treatment with large amounts of seed cane.

In Hawaii, seed treatment is practiced on certain plantations. The seed pieces are cut and placed in bags and these bags are lifted in slings and placed in the tanks of heated water. One treatment unit can take care of 1500 to 2000 bags per day which is sufficient to take care of the planting requirements on a large plantation. It is estimated that the cost of treatment is about one cent per bag, which is apparently not a prohibitive cost.

In Louisiana, the method of planting is quite different from that used in the tropics. Instead of using short seed pieces, whole stalks are planted, and instead of dropping the small seed pieces at definite intervals in the row, two running stalks and more are planted. In Louisiana, the amount of seed cane necessary to plant an acre is considerably more than in the tropics, and consequently under the best of conditions, the cost of treating sufficient seed cane to plant an acre in Louisiana would be considerably more than in the tropics.

In tests made in Louisiana, which have been made only on a small scale, there has been no way of estimating the extra cost. The extra cost includes an extra loading and unloading of the cane truck, the extra haul to the treating tank and the labor and fuel required to keep the boiler in operation. One year when a railroad car was fixed up as a tank at Napoleonville, it was estimated that the cost of treating a ton of cane was not much over a dollar. It may be assumed that if the hot-water treatment becomes a general practice, the agricultural engineers will be able to perfect equipment which will materially reduce the cost of treatment.

EVALUATION OF RESULTS

In evaluating the importance of the hot-water treatment for Louisiana, two things should be considered: *1st,* what immediate returns the planter may expect if he treats his cane, and *2nd,* the indirect effects to a plantation or area due to the gradual reduction of diseases and insect pests.

The increased yields which have been obtained in the plots planted with seed cane treated with hot water indicate that on the average with certain varieties, the planter will profit by treating his seed cane at planting time. The increases of both the plant and stubble cane should be considered. For convenience, a table (Table 20) has been prepared showing the combined plant and stubble cane increases which have been due to the hot-water treatment.

With the variety C.P.29/320, the increases in the August plantings have been negligible. In the September, October and November plantings, however, the total increases in tons per acre of the plant and stubble crops, due to treating the seed cane with hot water, were 5.4 tons, 4.8

tons and 5.2 tons. These are large enough increases to justify the added expense of the treatment. At the present price of cane ($7.06 per ton), these represent increased values of $38.12, $33.89 and $36.71 per acre as a result of the treatment. It seems self-evident, that after subtracting the cost of treatment and the expense of harvesting and milling the additional cane, there would still be substantial profits.

With the variety C.P.28/19, the increases of 3.8 tons in the September plantings, 4.1 tons in the October plantings and 4.5 tons in the November plantings represent values of $26.83, $28.95 and $31.77 per acre.

Based on limited data, it would seem that similar increases could be expected with C.P. 29/103, C.P. 34/120 and C.P. 29/120. On a similar basis the differences in yield obtained with C.P. 29/116 and Co. 290 did not seem sufficient to justify the treatment.

The indirect effects of the hot-water treatment in the general improvement program should not be overlooked. There are many diseases and insect pests of sugarcane. It is known that the hot-water treatment at 52°C. will eliminate or reduce the infection or infestation of many of these organisms on or in the seed cane. The chlorotic streak is entirely eliminated by the hot-water treatment. The spores of the red rot fungus on the surface of the stalks are destroyed by the treatment. What effect treatment may have on such diseases as the bacterial red stripe and top rot and the different leaf spots is at present unknown but it may be assumed that the treatment would be beneficial with these.

Two bacterial diseases which occur in tropical areas of the Western Hemisphere, the gumming disease in the West Indies and in Northern South America and the leaf scald in Brazil, from the information which is now available, are probably reduced in the seed cane by a temperature of 52°C. These diseases are not present in Louisiana but there is no assurance that they may not be introduced at some time in the future and they should continue to receive attention in Louisiana.

Perhaps the general use of the hot-water treatment of seed cane would tend to reduce many of these pests.

FUTURE INVESTIGATIONS

The project on the hot-water treatment as originally planned has been completed. Extensive tests have been made during a period of five years on nine plantations and the results of these have been presented in this bulletin. The investigations have shown what may be expected with the treatment on certain varieties. Much work, however, remains to be done, and many questions regarding the effect of the treatment on the sugarcane plant and the parasitic organisms attacking it, still need answering.

Most of the investigations have been concerned with the leading varieties of five years ago. It has been found that varieties vary in their response to the hot-water treatment. Significant increases in yields have been obtained with some varieties but not with others. New varieties of cane are coming on all of the time and some of these will eventually replace the varieties now in cultivation. If the hot-water treatment comes into general use or if it is found necessary to practice it in order to control some disease, information in regard to the response of the new varieties to the treatment will become important. No information is available on how the new varieties, C.P. 36/105 and C.P. 36-13, or any of the new seedlings which seem promising might respond to the treatment. To obtain this information on these canes, it would not be necessary to make tests all over the sugar belt. The present investigations indicate that this could be obtained satisfactorily on a single plantation.

It has been shown that the hot-water treatment stimulates the buds on the seed cane and this results in better stands in the spring. This suggests that it might be possible to reduce the amount of seed cane for planting. Planters in Louisiana have become so accustomed during the past hundred years to using two running stalks and a lap for planting that they might hesitate to risk a less amount. In general, it may be said that they would rather plant an excess amount of seed cane rather than to risk having gappy stands. If, however, based on sufficient experience, it is found that a less amount of seed cane treated with hot water would ordinarily give a satisfactory stand, the expense of planting would be materially lowered.

As the hot-water treatment stimulates the growth of the meristematic tissues in the buds, it follows that there must be some biochemical changes in the living tissues of the cane plant. At present, the data available give very little information as to the nature of these changes. These changes, which may be assumed to be modifications of one or more of the enzyme systems in the plant, are very interesting. If understood, they might throw some light on the difficult problems facing both the plant physiologist and the plant pathologist.

Also more information is needed on the effect of the hot-water treatment on the various diseases which attack the sugarcane plant.

SUMMARY

During a period of five years, tests were made to determine the effectiveness of the hot-water treatment on seed cane. Seed cane was submerged in hot water at a temperature of 52°C. for 20 minutes before planting. Replicated plots were planted with treated and untreated seed cane on nine plantations. Plantings were made in August, September, October and November.

The chlorotic streak virus in the stalks was completely destroyed or inactivated by the treatment.

The hot-water treatment stimulated the growth of the buds and the young shoots. Better stands were obtained with the treated than with the untreated seed cane.

Significant differences in the sucrose content of the cane, in plots planted with treated and untreated seed cane, were not observed.

In the August plantings, the differences in yield between the plots planted with treated and untreated seed cane were small. In the September, October and November plantings, material increases in yield were obtained with several varieties in the plots planted with treated seed cane. With such varieties as C.P. 29/320 and C.P. 28/19, these increases were from 2.5 to 4.5 tons per acre of plant cane. Smaller, but significant increases were also obtained with the stubble crops.

With a few varieties significant increases in yield were not obtained. With most varieties, it would appear that the profits to the planter would be increased by treating the seed cane.

APPENDIX

Data obtained from plots planted with untreated seed cane and seed cane treated with hot water at 52° C. for 20 minutes; germination, stands in field, chemical analyses of cane, and yields of plant and first year stubble crops:

Table 1. Fall germination, C.P. 29/320.
Table 2. Fall germination, C.P. 28/19.
Table 3. Fall germination, five other varieties.
Table 4. Spring stands, C.P. 29/320.
Table 5. Spring stands, C.P. 28/19.
Table 6. Spring stands, six other varieties.
Table 7. Analyses of plant and first year stubble cane, C.P. 29/320.
Table 8. Analyses of plant and first year stubble cane, C.P. 28/19.
Table 9. Analyses of plant and stubble cane of other varieties.
Table 10. Comparative yields of plant cane, C.P. 29/320.
Table 11. Comparative yields of stubble cane, C.P. 29/320.
Table 12. Comparative yields of plant cane, C.P. 28/19.
Table 13. Comparative yields of stubble cane, C.P. 28/19.
Table 14. Comparative yields of plant and stubble cane, Co. 281.
Table 15. Comparative yields of plant and stubble cane, Co. 290.
Table 16. Comparative yields of plant and stubble cane, C.P. 29/103.
Table 17. Comparative yields of plant and stubble cane, C.P. 29/116.
Table 18. Comparative yields of plant and stubble cane, C.P. 29/120.
Table 19. Comparative yields of plant cane, C.P. 34/120.
Table 20. Comparative yields of plant and stubble cane of eight varieties: summation table.

TABLE 1. Comparative Fall Germination Counts of Shoots in Plots Planted With Hot-Water Treated and Untreated Seed Cane on Nine Plantations, Variety C.P. 29/320.

Year	*August*		*September*		*October*		*November*	
	Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
Albania								
1940–41	1592	1663	634	1133	41	154	12	155
1941–42	280	312	70	489	145	520	...	...
1942–43	634	535	61	61	228	406	...	...
Average	835	837	255	561	138	360	12	155
Billeaud								
1940–41	1281	1334	459	729	213	448	3	32
1941–42	491	556	13	65	310	322	...	...
Average	886	945	236	397	262	385	3	32
Cinclare								
1940–41	1227	1243	675	848	501	589	0	10
1941–42	725	692	284	464	354	501	...	...
1942–43	255	277	343	451	213	379	...	...
Average	736	737	434	588	356	490	0	10
Glenwood								
1940–41	1145	799	676	852	377	447	21	148
1941–42	394	417	269	626	168	357	...	...
1942–43	394	410	332	340	22	131	...	...
Average	644	542	426	606	189	312	21	148
Greenwood								
1940–1941	1056	405	1353	1677	252	421	18	289
1941–42	972	1050	157	481	362	490	...	...
1942–43	144	205	230	345	5	95	...	...
Average	724	553	580	834	206	335	18	289
Lower Terrebonne								
1940–41	304	270	203	318	88	129	5	64
1941–42	1215	1097	259	435	203	398	...	...
1942–43	311	549	294	581	65	214	...	...
Average	610	639	252	445	119	247	5	64

TABLE I—Continued

Year	August		September		October		November	
	Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
				MEEKER				
1940–41	739	519	239	508	197	484	0	0
1941–42	162	187	135	236	119	307	...	...
1942–43	202	398	9	82	8	21	...	...
Average	368	368	128	275	108	271	0	0
				RACELAND				
1940–41	2032	3031	939	1323	369	504	13	114
1941–42	1762	1711	711	724	23	87	...	...
1942–43	756	1395	181	438	34	217	...	...
Average	1533	2046	610	828	142	269	13	114
				WESTOVER				
1940–41	1652	1773	699	858	382	498	0	10
1941–42	694	775	179	289	60	145	...	...
1942–43	119	308	46	253	159	498	...	...
Average	822	952	308	467	200	380	0	10
				AVERAGE OF 9 PLANTATIONS				
3 Years	792	843	363	562	188	337	8	91

TABLE 2. COMPARATIVE FALL GERMINATION COUNTS OF SHOOTS IN PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE ON SIX PLANTATIONS, VARIETY C.P. 28/19.

Year	*August*		*September*		*October*		*November*	
	Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
GLENWOOD								
1940–41	1072	1304	702	1097	386	577	12	191
1941–42	554	426	581	748	84	442	...	...
1942–43	416	478	432	378	6	186	...	...
Average	681	736	571	741	159	402	12	191
GREENWOOD								
1940–41	1329	1409	945	2124	486	877	30	587
1941–42	829	1037	120	549	544	723	...	...
Average	1079	1223	533	1337	515	800	30	587
LOWER TERREBONNE								
1940–41	470	474	209	434	69	272	19	146
1941–42	802	763	195	429	186	494	...	...
1942–43	277	394	233	704	47	215	...	...
Average	516	544	212	522	101	327	19	146
MEEKER								
1940–41	960	1113	681	763	604	1002	0	0
1941–42	248	265	176	364	203	417	...	...
1942–43	396	512	68	187	31	157	...	...
Average	535	630	308	438	279	525	0	0
RACELAND								
1940–41	2248	2351	892	1378	548	673	96	474
1941–42	807	873	807	873	5	33	...	...
1942–43	697	1299	267	652	57	469	...	...
Average	1251	1508	655	968	203	392	96	474
WESTOVER								
1940–41	1955	2024	678	816	515	691	8	62
1941–42	498	703	73	286	50	281	...	...
1942–43	163	236	12	263	73	381	...	...
Average	872	988	254	455	213	451	8	62
AVERAGE OF 6 PLANTATIONS								
3 years	807	921	416	709	229	464	28	243

TABLE 3. COMPARATIVE FALL GERMINATION COUNTS OF SHOOTS IN PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE OF FIVE VARIETIES.

Plantation	*Year*	*August*		*September*		*October*		*November*	
		Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
				Co. 281					
Cinclare........	1940–41	1519	778	807	841	659	629	3	67
	1941–42	599	610	402	400	259	444	...	...
	1942–43	334	271	432	542	179	364	...	...
	Average	817	553	547	594	366	479	3	67
				Co. 290					
Albania........	1940–41	1501	1303	823	977	13	76	8	78
	1941–42	647	639	100	682	406	808	...	...
Billeaud.......	1940–41	1980	2382	992	1115	738	800	13	42
	Average	1376	1441	638	925	386	561	11	60
				C.P. 29/103					
Albania........	1942–43	699	944	78	148	109	420	...	...
Greenwood.....	1942–43	180	397	208	469	2	82	...	...
	Average	440	671	143	309	56	251	...	...
				C.P. 29/116					
Billeaud.......	1941–42	548	761	95	220	542	540	...	...
	1942–43	473	819	377	510	319	603	...	...
	Average	511	790	236	365	431	572	...	...
				C.P. 29/120					
Billeaud.......	1942–43	368	589	283	352	239	636	...	...

TABLE 4. COMPARATIVE SPRING STANDS OF HOT-WATER TREATED AND UNTREATED CANE ON NINE PLANTATIONS, VARIETY C.P. 29/320.

		August		*September*		*October*		*November*	
Plantation	*Year*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
Albania........	1940–41	345	426	507	856	105	327	465	716
	1941–42	478	711	943	1748	418	903	255	477
	1942–43	1003	706	359	517	641	856	211	495
	1943–44	1142	1182	956	1445	831	1114	825	1092
	1944–45	686	1222	986	1528	858	1347	405	950
	Average	731	849	750	1219	571	909	432	746
Billeaud........	1940–41	380	463	443	808	348	776	218	584
	1941–42	1086	1307	531	876	542	876	480	494
	Average	733	885	487	842	445	826	349	539
Cinclare........	1940–41	935	948	909	1196	770	885	342	490
	1941–42	412	330	664	601	1002	968	566	1073
	1942–43	373	437	1075	1403	576	703	343	527
	1943–44	1699	1314	1043	1283	248	371	336	495
	1944–45	2433	1820	2334	3131	792	1433	832	1336
	Average	1170	970	1205	1523	678	872	484	784
Glenwood......	1940–41	481	349	751	835	422	552	433	688
	1941–42	1086	868	946	1500	403	615	350	433
	1942–43	152	130	619	669	252	488	330	510
	1943–44	2978	2993	4308	5076	834	1627	....	....
	1944–45	304	132	522	1039	462	713	....	....
	Average	1000	894	1429	1824	475	799	371	544
Greenwood......	1940–41	431	18	874	1155	411	667	449	804
	1941–42	1734	1552	1494	1829	591	997	382	619
	1942–43	604	795	901	879	375	544	352	582
	Average	923	788	1090	1288	459	736	394	668
Lower Terrebonne	1940–41	194	182	393	624	231	358	353	378
	1941–42	1024	815	363	491	204	584	315	524
	1942–43	1007	1118	1106	1247	288	427	236	277
	1943–44	1125	1118	763	843	497	727	140	353
	1944–45	1841	1889	1356	1850	320	301	331	297
	Average	1038	1024	796	1011	308	479	275	366
Meeker........	1940–41	410	327	171	576	303	545	31	101
	1941–42	279	342	374	517	272	530	241	188
	1942–43	945	1439	284	496	207	291	249	546
	1943–44	....	....	1097	1866	685	1320	....	....
	1944–45	....	....	....	....	676	948	....	....
	Average	545	703	482	864	429	727	174	278

TABLE 4—Continued

Plantation	Year	August		September		October		November	
		Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
Raceland.......	1940–41	726	886	812	1371	715	998	334	697
	1941–42	1383	1261	1486	1517	320	440	258	388
	1942–43	1091	1196	896	1112	451	745	357	474
	1943–44	1851	2156	981	1336	378	654	249	400
	1944–45	....	....	1048	1970	740	1773	885	1536
	Average	1263	1375	1045	1461	521	922	419	699
Westover.......	1940–41	792	803	869	1120	547	651	331	456
	1941–42	1812	2085	754	963	493	776	424	663
	1942–43	1274	1622	458	761	636	968	282	512
	1943–44	2221	2147	1228	1746	509	605	436	517
	Average	1525	1664	827	1148	546	750	368	537
Average for nine plantations.....	1940–45	1020	1030	937	1284	496	780	372	591

TABLE 5. Comparative Spring Stands of Hot-Water Treated and Untreated Cane on Six Plantations, Variety C.P. 28/19.

Plantation	Year	August		September		October		November	
		Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
Glenwood......	1940–41	674	677	713	983	490	582	448	595
	1941–42	1486	976	1583	2073	439	608	335	436
	1942–43	175	170	652	830	210	575	378	464
	1943–44	2260	3222	2676	3442	519	1098	....	....
	Average	1149	1261	1406	1832	415	716	387	498
Greenwood.....	1940–41	428	282	295	1550	568	1080	706	1128
	1941–42	1814	2246	1321	2140	754	1513	293	586
	Average	1121	1264	808	1845	661	1297	500	857
Lower Terrebonne	1940–41	400	433	591	844	462	619	519	516
	1941–42	1854	1836	557	812	518	672	518	760
	1942–43	1092	1336	1390	1717	384	614	368	580
	1943–44	1320	1322	1001	1290	880	1243	591	831
	Average	1167	1232	885	1166	561	787	499	672
Meeker........	1940–41	486	242	499	502	678	749	181	403
	1941–42	585	439	410	635	467	512	446	213
	1942–43	1458	1804	375	566	281	429	460	538
	1943–44	....	....	1051	1072	904	1228	....	....
	Average	843	828	584	694	583	730	362	385
Raceland.......	1940–41	607	732	390	875	597	685	525	738
	1941–42	1028	1541	812	1646	134	282	281	440
	1942–43	582	1026	813	1017	371	543	349	603
	1943–44	1447	1812	662	1741	188	587	272	389
	Average	916	1278	669	1320	323	524	357	543
Westover.......	1940–41	730	545	712	856	657	741	454	508
	1941–42	1373	1857	481	676	556	842	429	553
	1942–43	1213	1008	325	883	369	770	446	479
	1943–44	2090	2096	1041	1524	501	630	524	491
	Average	1352	1377	640	985	521	746	463	508
Average for six plantations...	1940–44	1100	1219	834	1258	497	755	426	563

TABLE 6. COMPARATIVE SPRING STAND COUNTS OF HOT-WATER TREATED AND UNTREATED CANE OF SIX VARIETIES OF SUGARCANE.

Plantation	*Year*	*August*		*September*		*October*		*November*	
		Check	*Treated*	*Check*	*Treated*	*Check*	*Treated*	*Check*	*Treated*
				Co. 281					
Cinclare........	1940–41	331	144	424	661	702	710	454	457
	1941–42	248	279	470	487	592	1001	328	556
	1942–43	242	162	879	878	442	544	400	602
	1943–44	1487	1419	1245	1651	446	614	337	476
	Average	577	501	755	919	546	717	380	523
				Co. 290					
Albania........	1940–41	383	485	840	858	120	297	505	668
	1941–42	1239	1182	1461	1451	703	1302	517	573
Billeaud........	1940–41	541	551	738	1006	745	857	555	481
	Average	721	739	1013	1105	523	819	526	574
				C.P. 29/103					
Albania........	1942–43	1141	1446	454	477	383	780	186	743
	1943–44	1225	1345	853	1323	805	1315	556	1252
Greenwood.....	1942–43	656	726	567	845	280	583	339	633
	Average	1007	1172	625	881	489	893	360	876
				C.P. 29/116					
Billeaud........	1941–42	1998	1846	1458	1833	880	1086	562	218
	1943–44	860	926	726	1045	795	897	667	606
	1944–45	....	....	684	1029	840	988	....	....
	Average	1429	1386	956	1302	838	990	615	412
				C.P. 29/120					
Billeaud........	1942–43	800	1309	500	567	531	626	242	488
	1943–44	684	708	328	527	565	635	517	679
	1944–45	....	....	515	720	838	890	....	....
	Average	742	1008	448	605	645	717	380	584
				C.P. 34/120					
Albania........	1944–45	1641	2425	2103	2375	1205	1751	1162	1654
Cinclare........	1944–45	2903	1970	3359	4130	1190	2198	1599	1864
Glenwood.......	1944–45	329	420	678	1181	579	842	....	....
Lower Terrebonne........	1944–45	2746	2539	1796	2119	375	441	557	411
Meeker........	1944–45	....	....	....	....	1005	1389	....	....
Raceland.......	1944–45	....	....	2688	3736	2078	3156	1188	1700
	Average	1905	1839	2125	2708	1072	1630	1127	1407

TABLE 7. Analyses of Plant and First Year Stubble Cane From Plots Planted With Hot-Water Treated and Untreated Seed Cane on Nine Plantations, Variety C.P. 29/320.

Plantation	*Date Planted*	*Treatment*	*Plant Cane (2 Yr. Ave.)*			*Stubble (1 Yr. Ave.)*		
			Brix	*Sucrose*	*Purity*	*Brix*	*Sucrose*	*Purity*
Albania..........	August	Check	16.76	13.87	82.76	16.28	13.01	81.12
		Treated	17.06	14.38	84.29	15.93	12.86	80.69
	September	Check	16.82	14.08	83.71	15.96	12.80	80.16
		Treated	17.21	14.52	84.37	16.10	13.14	81.59
	October	Check	16.53	13.71	82.94	15.75	12.65	80.31
		Treated	16.86	14.05	83.33	16.12	13.21	81.92
	November	Check	16.85	14.08	83.56	15.94	12.87	80.73
		Treated	17.25	14.64	84.87	16.34	13.37	81.78
Billeaud.........	August	Check	17.24	13.89	80.57	17.60	14.45	82.12
		Treated	17.69	14.30	80.84	17.73	14.64	82.60
	September	Check	17.45	13.91	79.71	17.35	14.15	81.53
		Treated	17.52	13.81	78.82	17.48	14.24	81.46
	October	Check	17.29	13.73	79.41	17.50	14.17	80.94
		Treated	17.83	14.10	79.08	17.75	14.40	81.12
	November	Check	17.36	13.73	79.09	17.50	14.38	82.15
		Treated	17.26	13.55	78.51	17.65	14.29	80.99
Cinclare.........	August	Check	17.22	13.65	79.27	17.04	13.91	81.62
		Treated	17.31	14.21	82.09	16.70	13.60	81.42
	September	Check	16.50	12.85	77.88	16.87	13.73	81.36
		Treated	17.05	13.66	80.12	17.15	14.07	82.00
	October	Check	16.78	13.24	78.90	17.00	13.83	81.29
		Treated	16.85	13.25	78.63	16.76	13.69	81.64
	November	Check	16.81	13.34	79.36	17.18	14.03	81.65
		Treated	16.85	13.37	79.35	16.78	13.60	81.04
Glenwood........	August	Check	17.00	14.18	83.41	15.61	10.79	69.14
		Treated	16.69	13.94	83.52	15.38	10.44	67.87
	September	Check	17.02	14.38	84.49	15.47	11.06	71.56
		Treated	16.92	14.25	84.21	15.70	10.79	68.71
	October	Check	16.52	13.76	84.22	16.17	11.37	70.36
		Treated	16.58	13.87	83.65	16.16	11.20	69.33
	November	Check	16.42	13.48	82.10	15.82	10.90	68.86
		Treated	16.43	13.82	84.11	15.65	10.44	66.65
Greenwood.......	August.....	Check	17.34	14.17	81.72	.....	.....	.....
		Treated	17.02	13.81	81.14	.....	.....	.....
	September	Check	17.32	14.24	82.22	14.87	11.02	74.11
		Treated	17.44	14.35	82.28	14.70	10.27	69.89
	October	Check	16.82	13.51	80.32	14.66	10.48	71.45
		Treated	16.88	13.25	78.50	14.87	10.86	73.01
	November	Check	17.06	13.79	80.83	15.20	11.26	74.05
		Treated	16.83	13.61	80.87	14.99	10.78	71.91

TABLE 7—Continued

Plantation	*Date Planted*	*Treatment*	*Plant Cane (2 Yr. Ave.)*			*Stubble (1 Yr. Ave.)*		
			Brix	*Sucrose*	*Purity*	*Brix*	*Sucrose*	*Purity*
Lower Terrebonne	August	Check	16.85	13.97	82.91	15.92	12.68	79.57
		Treated	17.33	14.15	81.65	16.11	12.44	77.44
	September	Check	16.63	13.65	82.08	15.39	12.17	79.09
		Treated	16.96	14.23	83.90	15.92	12.39	79.14
	October	Check	16.63	13.83	83.16	16.03	12.89	80.40
		Treated	16.95	14.22	83.89	15.74	12.53	79.47
	November	Check	16.95	14.08	83.07	16.22	13.28	81.90
		Treated	17.18	14.44	84.05	16.00	12.98	81.02
Meeker..........	August	Check	16.08	12.86	79.98	16.73	13.01	77.70
		Treated	16.03	12.76	79.60	16.80	13.32	79.23
	September	Check	16.10	12.78	79.38	16.73	13.14	78.48
		Treated	16.00	12.61	78.81	16.50	13.04	78.70
	October	Check	16.27	12.77	78.49	16.54	12.99	78.88
		Treated	16.08	12.50	77.74	16.69	12.95	77.58
	November	Check	15.85	12.37	78.04	16.80	13.25	78.83
		Treated	16.28	12.98	79.73	17.24	13.66	79.20
Raceland........	August	Check	17.09	13.77	80.57	15.67	11.24	71.61
		Treated	16.18	12.81	79.17	15.75	11.48	72.88
	September	Check	16.57	13.24	79.90	15.60	11.33	72.59
		Treated	16.30	12.98	79.63	15.59	11.02	69.06
	October	Check	15.57	12.04	77.33	15.50	11.73	75.70
		Treated	15.99	12.48	78.05	15.43	11.30	73.27
	November	Check	15.27	11.75	76.95	15.70	11.69	74.41
		Treated	15.56	12.10	77.76	15.20	11.30	74.33
Westover........	August	Check	17.18	13.88	80.79	15.99	12.76	79.76
		Treated	17.07	13.75	80.55	16.20	13.00	80.15
	September	Check	16.46	12.86	78.13	15.93	12.84	80.57
		Treated	16.58	13.04	78.65	16.02	12.92	80.63
	October	Check	16.37	12.75	77.89	16.16	12.79	79.14
		Treated	16.36	12.74	77.87	16.23	12.99	80.02
	November	Check	16.33	12.75	78.08	16.19	12.76	78.77
		Treated	16.45	12.88	78.30	16.36	13.14	80.35

TABLE 8. ANALYSES OF PLANT AND FIRST YEAR STUBBLE CANE FROM PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE ON SIX PLANTATIONS, VARIETY C.P. 28/19.

Plantation	*Date Planted*	*Treatment*	*Plant Cane (2 Yr. Ave.)*			*Stubble (1 Yr. Ave.)*		
			Brix	*Sucrose*	*Purity*	*Brix*	*Sucrose*	*Purity*
Glenwood........	August	Check	17.70	15.04	84.97	15.89	11.44	71.92
		Treated	17.26	14.95	86.61	15.98	11.45	71.62
	September	Check	17.78	15.31	86.11	16.22	11.66	71.85
		Treated	17.44	14.83	85.03	15.50	10.79	69.60
	October	Check	17.34	14.57	84.03	16.83	12.31	73.13
		Treated	17.73	15.34	86.52	16.18	12.03	74.28
	November	Check	16.71	13.85	82.88	17.03	12.80	75.13
		Treated	17.50	14.70	84.00	15.85	11.21	70.72
Greenwood.......	August	Check	18.21	15.29	83.96	15.53	11.22	72.17
		Treated	17.91	14.95	83.47	15.32	11.23	73.23
	September	Check	17.88	15.03	84.06	15.48	11.41	73.65
		Treated	18.58	15.76	84.82	15.58	11.50	73.81
	October	Check	17.15	14.09	82.16	15.63	11.43	73.16
		Treated	17.54	14.39	82.04	15.56	11.52	74.05
	November	Check	18.30	15.44	84.37	17.03	13.41	78.68
		Treated	18.44	16.05	87.04	17.03	13.46	78.99
Lower Terrebonne	August	Check	18.43	15.83	85.89	17.79	14.86	83.53
		Treated	18.22	16.10	88.36	17.39	14.12	81.16
	September	Check	18.46	15.87	85.97	16.97	13.97	82.30
		Treated	18.61	16.21	87.10	17.87	14.18	79.37
	October	Check	18.58	15.94	85.79	17.83	14.85	83.27
		Treated	18.08	15.54	85.95	17.33	13.71	79.07
	November	Check	18.66	16.10	86.28	17.67	14.80	83.75
		Treated	18.74	16.06	85.70	18.07	15.23	84.30
Meeker..........	August	Check	16.32	13.09	80.21	17.54	14.41	82.09
		Treated	16.09	12.96	80.55	17.10	14.10	82.52
	September	Check	15.73	12.60	80.10	16.99	13.69	80.59
		Treated	16.58	13.62	82.15	17.33	13.99	80.74
	October	Check	16.14	12.97	80.36	17.40	14.59	83.83
		Treated	16.21	13.15	81.12	17.06	13.72	80.37
	November	Check	15.96	12.77	80.01	17.42	14.09	80.85
		Treated	15.99	12.79	79.99	17.38	14.01	80.51
Raceland........	August	Check	16.97	13.67	80.55	15.19	11.04	71.55
		Treated	17.23	13.82	80.21	15.11	10.13	66.94
	September	Check	16.07	12.72	79.15	15.49	11.19	72.27
		Treated	16.88	13.60	80.57	14.87	10.31	69.39
	October	Check	15.08	11.65	77.25	15.46	11.61	75.11
		Treated	15.95	12.70	79.62	14.75	10.90	73.80
	November	Check	16.19	12.71	78.50	15.60	11.68	74.85
		Treated	15.45	12.16	78.71	15.73	12.03	76.45
Westover........	August	Check	18.15	15.08	83.09	16.79	13.74	81.80
		Treated	17.73	14.50	81.78	16.54	13.68	82.72
	September	Check	17.99	14.91	82.88	17.17	14.26	83.06
		Treated	18.05	14.98	82.99	16.85	13.79	81.84
	October	Check	16.61	14.67	88.32	17.38	14.48	83.28
		Treated	18.07	14.95	82.73	16.78	13.88	82.66
	November	Check	17.32	14.18	81.87	17.28	14.26	82.44
		Treated	17.95	14.76	82.23	17.04	14.09	82.66

TABLE 9. ANALYSES OF PLANT AND FIRST YEAR STUBBLE CANE FROM PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE, VARIETIES CO. 281, CO. 290 AND C.P. 29/116.

Plantation	*Date Planted*	*Treatment*	*Plant Cane (2 Yr. Ave.)*			*Stubble (1 Yr. Ave.)*		
			Brix	*Sucrose*	*Purity*	*Brix*	*Sucrose*	*Purity*
			Co. 281					
Cinclare.........	August	Check	15.83	12.59	79.53	15.91	12.91	81.19
		Treated	15.46	12.00	77.62	15.75	12.77	81.09
	September	Check	15.58	12.34	79.20	15.88	13.05	82.10
		Treated	16.06	12.84	79.95	16.15	13.26	82.11
	October	Check	15.19	11.52	75.84	15.89	12.91	81.25
		Treated	15.68	12.15	77.49	15.32	12.34	80.45
	November	Check	15.16	11.57	76.32	15.98	13.04	81.48
		Treated	15.16	11.75	77.51	15.49	12.47	80.50
			Co. 290					
Albania..........	August	Check	16.01	13.04	81.45	15.70	12.70	81.13
		Treated	15.52	12.24	78.87	15.09	12.09	80.11
	September	Check	15.88	12.74	80.23	15.56	12.24	78.60
		Treated	16.17	13.02	80.52	15.18	11.99	78.93
	October	Check	15.60	12.64	81.03	15.24	12.22	79.33
		Treated	15.87	12.97	81.73	14.71	11.63	79.03
	November	Check	16.15	13.21	81.80	15.49	12.35	79.69
		Treated	15.69	12.67	80.75	15.32	12.24	79.88
Billeaud*........	August	Check	14.85	10.51	70.77	16.20	12.41	76.53
		Treated	14.38	10.26	71.35	16.57	12.66	76.55
	September	Check	14.85	10.63	71.58	16.13	12.09	74.97
		Treated	14.87	10.65	71.62	16.20	12.15	74.92
	October	Check	14.24	10.09	70.86	15.30	11.00	71.92
		Treated	14.77	10.57	71.56	15.70	11.57	73.70
	November	Check	14.48	10.24	70.72	16.00	11.88	74.21
		Treated	14.48	10.14	70.03	16.15	11.86	73.41
			C.P. 29/116					
Billeaud*........	August	Check	16.90	12.41	73.43	.....	.....	.....
		Treated	16.73	12.63	75.49	.....	.....	.....
	September	Check	16.65	12.80	76.88	.....	.....	.....
		Treated	16.65	12.39	74.41	.....	.....	.....
	October	Check	16.70	12.39	74.19	.....	.....	.....
		Treated	16.80	12.32	73.33	.....	.....	.....
	November	Check	16.60	12.40	74.70	.....	.....	.....
		Treated	16.85	13.10	77.74	.....	.....	.....

* One year's data only on plant cane.

TABLE 10. COMPARATIVE YIELDS OF PLANT CANE IN TONS PER ACRE OF PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED CANE FOR 5 YEARS ON 9 PLANTATIONS, VARIETY C.P. 29/320.

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
ALBANIA												
1940–41	12.2	16.4	4.2	17.4	20.3	2.9	7.8	13.6	5.8	18.1	19.8	1.7
1941–42	15.1	18.9	3.8	23.3	25.8	2.5	21.4	22.7	1.3	18.5	27.9	9.4
1942–43	21.7	19.0	−2.7	15.1	17.5	2.4	21.0	23.5	2.5	9.7	17.8	8.1
1943–44	21.6	22.7	1.1	21.5	25.2	3.7	23.6	26.9	3.3	29.1	28.0	−1.1
1944–45	15.3	18.7	3.4	17.5	24.9	7.4	19.7	20.9	1.2	14.4	20.0	5.6
Average	17.2	19.1	1.9	19.0	22.7	3.7	18.7	21.5	2.8	18.0	22.7	4.7
BILLEAUD												
1940–41	17.6	22.4	4.8	19.7	23.8	4.1	21.3	27.1	5.8	20.0	27.0	7.0
1941–42	27.3	28.5	1.2	21.2	25.1	3.9	22.0	18.6	−3.4	21.6	17.0	−4.6
Average	22.5	25.5	3.0	20.5	24.5	4.0	21.7	22.9	1.2	20.8	22.0	1.2
CINCLARE												
1940–41	29.7	27.3	−2.4	34.0	34.9	0.9	36.6	39.0	2.4	37.6	30.8	−6.8
1941–42	28.0	22.3	−5.7	29.7	31.8	2.1	34.2	27.5	−6.7	31.5	36.8	5.3
1942–43	14.5	16.8	2.3	28.2	30.8	2.6	24.9	26.2	1.3	22.4	27.6	5.2
1943–44	26.7	26.9	0.2	25.1	26.7	1.6	22.5	28.1	5.6	25.7	30.4	4.7
1944–45	32.6	29.2	−3.4	29.0	32.6	3.6	29.0	34.6	5.6	28.9	33.1	4.2
Average	26.3	24.5	−1.8	29.2	31.4	2.2	29.4	31.1	1.7	29.2	31.7	2.5
GLENWOOD												
1940–41	21.8	19.5	−2.3	25.6	27.6	2.0	24.6	27.2	2.6	25.2	30.6	5.4
1941–42	23.9	22.5	−1.4	25.3	26.3	1.0	19.3	22.0	2.7	16.5	18.6	2.1
1942–43	24.8	26.6	1.8	26.7	31.4	4.7	23.4	28.7	5.3	25.8	32.6	6.8
1943–44	30.8	33.5	2.7	35.5	36.0	0.5	27.4	33.0	5.6	....	....	....
1944–45	10.9	8.8	−2.1	19.8	28.0	8.2	25.7	28.1	2.4	....	....	....
Average	22.4	22.2	−0.2	26.6	29.9	3.3	24.1	27.8	3.7	22.5	27.3	4.8
GREENWOOD												
1940–41	19.0	1.4	−17.6	26.7	30.2	2.6	33.4	34.2	0.8	30.4	36.2	5.8
1941–42	33.8	32.6	−1.2	31.4	32.8	1.4	29.0	31.4	2.4	27.1	31.9	4.8
1942–43	32.2	35.8	3.6	34.8	33.7	−1.1	32.2	38.4	6.2	31.7	35.9	4.2
Average	28.3	23.3	−5.0	31.3	32.2	0.9	31.5	34.7	3.2	29.7	34.7	5.0

TABLE 10—Continued

Year	August			September			October			November		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
						LOWER TERREBONNE						
1940–41	18.0	13.8	−4.2	27.3	28.5	1.2	20.2	25.2	5.0	28.3	27.2	−1.1
1941–42	14.0	15.5	1.5	7.7	11.8	4.1	11.2	16.3	5.1	14.5	14.9	0.4
1942–43	32.6	31.1	−1.5	34.4	34.6	0.2	20.7	26.2	5.5	17.3	18.1	0.8
1943–44	27.6	29.3	1.7	26.0	26.9	0.9	22.7	27.6	4.9	15.3	22.6	7.3
1944–45	29.7	30.6	0.9	23.1	28.1	5.0	18.9	17.5	−1.4	16.6	15.3	−1.3
Average	24.4	24.1	−0.3	23.7	26.0	2.3	18.7	22.6	3.9	18.4	19.6	1.2
						MEEKER						
1940–41	28.9	26.6	−2.3	20.5	33.7	13.2	30.4	37.4	7.0	10.7	17.7	7.0
1941–42	25.5	28.1	2.6	31.0	33.8	2.8	26.0	31.7	5.7	27.2	25.7	−1.5
1942–43	40.1	42.9	2.8	31.1	35.6	4.5	26.2	29.1	2.9	36.3	38.5	2.2
1943–44	....	....	....	34.4	43.5	9.1	32.9	40.0	7.1	....	....	....
1944–45	....	....	.....	....	....	...	28.4	27.1	−1.3	....	....	....
Average	31.5	32.5	1.0	29.3	36.7	7.4	28.8	33.1	4.3	24.7	27.3	2.6
						RACELAND						
1940–41	24.6	27.8	3.2	28.1	33.3	5.2	27.8	32.0	4.2	28.1	30.3	2.2
1941–42	28.5	26.6	−1.9	26.1	23.8	−2.3	11.1	13.2	2.1	10.0	13.5	3.5
1942–43	31.1	32.2	1.1	28.1	35.1	7.0	27.3	29.8	2.5	23.2	28.1	4.9
1943–44	33.1	38.2	5.1	31.3	37.2	5.9	31.8	35.6	3.8	27.6	34.1	6.5
1944–45	....	....	...	35.4	38.2	2.8	29.1	37.1	8.0	28.6	34.5	5.9
Average	29.3	31.2	1.9	29.8	33.5	3.7	25.4	29.5	4.1	23.5	28.1	4.6
						WESTOVER						
1940–41	30.9	30.9	0.0	34.2	37.3	3.1	39.0	38.8	−0.2	33.0	38.6	5.6
1941–42	31.0	30.8	−0.2	26.8	28.3	1.5	21.7	23.9	2.2	19.3	24.0	4.7
1942–43	31.8	32.2	0.4	21.3	29.3	8.0	35.2	36.5	1.3	30.2	33.0	2.8
1943–44	48.1	50.3	2.2	50.4	54.3	3.9	42.2	49.8	7.6	40.6	41.1	0.5
Average	35.5	36.1	0.6	33.2	37.3	4.1	34.5	37.3	2.8	30.8	34.2	3.4
Average for 9 plantations	26.0	26.0	0.0	27.0	30.5	3.5	25.7	28.9	3.2	24.0	27.4	3.4

TABLE 11. COMPARATIVE YIELDS OF STUBBLE CANE IN TONS PER ACRE OF HOT-WATER TREATED AND UNTREATED CANE ON NINE PLANTATIONS, VARIETY C.P. 29/320.

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
ALBANIA												
1940–42	6.3	7.6	1.3	7.4	10.0	2.6	4.3	6.2	1.9	9.5	10.5	1.0
1941–43	21.7	21.3	−0.4	21.7	22.2	0.5	24.4	23.7	−0.7	22.7	25.5	2.8
1942–44	16.5	15.2	−1.3	17.1	14.6	−2.5	17.0	16.2	−0.8	13.1	15.4	2.3
1943–45	20.9	22.9	2.0	21.1	22.6	1.5	22.6	26.0	3.4	29.2	26.2	−3.0
Average	16.4	16.8	0.4	16.8	17.4	0.6	17.1	18.0	0.9	18.6	19.4	0.8
BILLEAUD												
1941–43	16.7	20.9	4.2	21.0	23.7	2.7	14.4	12.2	−2.2	9.6	12.3	2.7
Average	16.7	20.9	4.2	21.0	23.7	2.7	14.4	12.2	−2.2	9.6	12.3	2.7
CINCLARE												
1940–42	16.4	12.9	−3.5	20.8	20.9	0.1	22.8	22.4	−0.4	26.9	22.9	−4.0
1941–43	8.8	11.1	2.3	13.7	17.8	4.1	22.0	16.9	−5.1	19.7	24.3	4.6
1943–45	23.8	25.6	1.8	26.5	25.8	−0.7	24.3	26.6	2.3	26.0	27.5	1.5
Average	16.3	16.5	0.2	20.3	21.5	1.2	23.0	22.0	−1.0	24.2	24.9	0.7
GLENWOOD												
1940–42	11.0	10.4	−0.6	11.1	14.9	3.8	13.7	15.3	1.6	18.0	17.2	−0.8
1941–43	17.8	19.6	1.8	21.4	22.6	1.2	22.0	24.2	2.2	24.1	23.4	−0.7
1942–44	14.3	16.5	2.2	17.0	19.1	2.1	17.3	20.0	2.7	16.3	17.2	0.9
1943–45	27.6	28.4	0.8	28.1	30.7	2.6	28.2	32.1	3.9	....	....	....
Average	17.7	18.7	1.0	19.4	21.8	2.4	20.3	22.9	2.6	19.5	19.3	−0.2
GREENWOOD												
1940–42	7.8	0.3	−7.5	13.2	16.6	3.4	16.6	24.2	7.8	14.8	26.9	12.1
1941–43	27.7	27.8	0.1	26.4	26.1	−0.3	31.1	31.6	0.5	30.8	35.3	4.5
1942–44	29.4	29.1	−0.3	28.6	29.3	0.7	31.4	31.1	−0.3	32.4	37.2	4.8
Average	21.6	19.1	−2.5	22.7	24.0	1.3	26.4	29.0	2.6	26.0	33.1	7.1
LOWER TERREBONNE												
1940–42	13.0	10.5	−2.5	15.5	19.6	4.1	14.9	18.9	4.0	19.5	16.3	−3.2
1942–44	17.3	17.9	0.6	19.0	18.0	−1.0	17.2	18.6	1.4	15.8	14.8	−1.0
1943–45	23.1	26.5	3.4	24.5	25.3	0.8	17.2	18.9	1.7	18.9	23.1	4.2
Average	17.8	18.3	0.5	19.7	21.0	1.3	16.4	18.8	2.4	18.1	18.1	0.0

TABLE 11—Continued

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
MEEKER												
1940–42	15.0	14.4	−0.6	11.9	19.6	7.7	17.5	20.9	3.4	8.1	11.2	3.1
1942–44	27.5	30.2	2.7	30.6	31.8	1.2	25.5	23.7	−1.8	30.9	32.8	1.9
Average	21.3	22.3	1.0	21.3	25.7	4.4	21.5	22.3	0.8	19.5	22.0	2.5
RACELAND												
1940–42	21.9	22.9	1.0	24.9	27.0	2.1	26.2	28.4	2.2	25.9	26.9	1.0
1941–43	29.5	30.7	1.2	29.2	31.3	2.1	31.0	31.7	0.7	28.8	34.0	5.2
Average	25.7	26.8	1.1	27.1	29.2	2.1	28.6	30.1	1.5	27.4	30.5	3.1
WESTOVER												
1941–43	34.4	35.0	0.6	36.4	37.3	0.9	24.8	33.6	8.8	30.0	31.6	1.6
1942–44	13.3	17.9	4.6	12.3	14.7	2.4	20.2	19.1	−1.1	14.8	24.4	9.6
1943–45	32.5	32.6	0.1	33.5	37.3	3.8	34.2	38.6	4.4	39.2	38.1	−1.1
Average	26.7	28.5	1.8	27.4	29.8	2.4	26.4	30.4	4.0	28.0	31.4	3.4
Average for nine plantations	19.8	20.3	0.5	21.3	23.2	1.9	21.6	23.2	1.6	21.9	23.7	1.8

TABLE 12. COMPARATIVE YIELDS OF PLANT CANE IN TONS PER ACRE OF PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE, VARIETY C.P. 28/19.

Year.	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
GLENWOOD												
1940–41	25.6	26.8	1.2	25.4	29.2	3.8	30.8	27.9	−2.9	27.1	28.3	1.2
1941–42	26.2	24.3	−1.9	28.5	29.4	0.9	16.5	18.1	1.6	15.0	17.8	2.8
1942–43	18.8	20.4	1.6	22.1	22.7	0.6	10.7	17.7	7.0	21.6	25.1	3.5
1943–44	27.9	30.9	3.0	31.6	29.9	−1.7	20.6	27.9	7.3	....	....	....
Average	24.6	25.6	1.0	26.9	27.8	0.9	19.7	22.9	3.2	21.2	23.7	2.5
GREENWOOD												
1940–41	18.4	13.9	−4.5	18.1	32.4	14.3	30.5	34.9	4.4	30.0	30.3	0.3
1941–42	30.0	32.4	2.4	27.4	30.5	3.1	30.1	35.7	5.6	19.1	28.9	9.8
Average	24.2	23.2	−1.0	22.8	31.5	8.7	30.3	35.3	5.0	24.6	29.6	5.0
LOWER TERREBONNE												
1940–41	22.8	22.8	0.0	24.3	26.3	2.0	20.8	25.1	4.3	26.1	24.4	−1.7
1941–42	16.0	14.1	−1.9	10.1	12.3	2.2	14.2	14.9	0.7	14.9	16.7	1.8
1942–43	21.7	23.0	1.3	27.3	27.7	0.4	14.1	17.5	3.4	16.4	18.4	2.0
1943–44	21.2	23.6	2.4	17.5	21.5	4.0	21.5	23.6	2.1	16.2	18.2	2.0
Average	20.4	20.9	0.5	19.8	22.0	2.2	17.7	20.3	2.6	18.4	19.4	1.0
MEEKER												
1940–41	33.7	25.5	−8.2	32.9	34.3	1.4	33.2	34.5	1.3	22.7	33.1	10.4
1941–42	32.1	30.1	−2.0	28.7	32.3	3.6	29.6	29.3	−0.3	30.8	24.4	−6.4
1942–43	35.9	35.3	−0.6	30.3	31.7	1.4	31.5	31.3	−0.2	39.5	42.3	2.8
1943–44	....	....	....	42.2	41.3	−0.9	42.7	40.1	−2.6	....	....	....
Average	33.9	30.3	−3.6	33.5	34.9	1.4	34.3	33.8	−0.5	31.0	33.3	2.3
RACELAND												
1940–41	26.0	27.0	1.0	21.8	28.6	6.8	24.6	24.1	−0.5	28.0	35.6	7.6
1941–42	23.8	23.4	−0.4	20.9	20.4	−0.5	6.6	9.2	2.6	10.0	10.6	0.6
1942–43	21.8	25.9	4.1	27.6	30.5	2.9	19.4	24.2	4.8	18.1	26.5	8.4
1943–44	26.4	30.1	3.7	23.1	28.9	5.8	19.5	25.1	5.6	25.6	28.3	2.7
Average	24.5	26.6	2.1	23.4	27.1	3.7	17.5	20.7	3.2	20.4	25.3	4.9
WESTOVER												
1940–41	32.2	24.7	−7.5	34.0	33.1	−0.9	37.9	37.1	−0.8	35.7	34.2	−1.5
1941–42	29.4	27.8	−1.6	24.2	22.6	−1.6	22.2	25.2	3.0	15.5	20.0	4.5
1942–43	22.6	22.0	−0.6	12.2	21.3	9.1	24.5	26.2	1.7	22.8	22.2	−0.6
1943–44	37.7	43.7	6.0	43.6	42.9	−0.7	37.2	41.8	4.6	36.8	41.8	5.0
Average	30.5	29.6	−0.9	28.5	30.0	1.5	30.5	32.6	2.1	27.7	29.6	1.9
Average for six plantations	26.2	26.1	−0.1	26.1	28.6	2.5	24.5	26.9	2.4	23.6	26.4	2.8

TABLE 13. COMPARATIVE YIELDS OF FIRST YEAR STUBBLE CANE IN TONS PER ACRE IN PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE AT SIX PLANTATIONS, VARIETY C.P. 28/19.

	August			*September*			*October*			*November*		
Year	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
						GLENWOOD						
1940–42	12.3	14.9	2.6	12.2	14.3	2.1	11.5	13.6	2.1	7.9	15.6	7.7
1941–43	18.1	18.1	0.0	19.9	22.6	2.7	16.1	16.2	0.1	13.7	15.7	2.0
1942–44	7.6	6.9	−0.7	9.6	10.7	1.1	5.8	8.6	2.8	13.7	16.6	2.9
1943–45	27.0	27.8	0.8	28.1	29.2	1.1	26.3	29.2	2.9	....	....	....
Average	16.3	16.9	0.6	17.5	19.2	1.7	14.9	16.9	2.0	11.8	16.0	4.2
						GREENWOOD						
1940–42	14.5	10.7	−3.8	13.4	20.9	7.5	25.2	26.1	0.9	20.5	25.3	4.8
1941–43	26.2	28.8	2.6	22.0	24.6	2.6	29.3	32.2	2.9	26.1	28.3	2.2
Average	20.4	19.8	−0.6	17.7	22.8	5.1	27.3	29.2	1.9	23.3	26.8	3.5
						LOWER TERREBONNE						
1940–42	14.2	12.3	−1.9	15.0	15.4	0.4	14.5	17.2	2.7	17.0	14.9	−2.1
1942–44	14.4	14.3	−0.1	18.3	17.8	−0.5	8.7	15.7	7.0	14.8	12.7	−2.1
1943–45	21.4	21.8	0.4	15.9	19.7	3.8	17.4	20.0	2.6	16.7	16.4	−0.3
Average	16.7	16.1	−0.6	16.4	17.6	1.2	13.5	17.6	4.1	16.2	14.7	−1.5
						MEEKER						
1940–42	19.0	15.0	−4.0	19.8	18.9	−0.9	25.5	23.3	−2.2	13.6	20.8	7.2
1942–44	17.0	23.4	6.4	21.5	21.9	0.4	32.9	32.1	−0.8	33.6	32.0	−1.6
Average	18.0	19.2	1.2	20.7	20.4	−0.3	29.2	27.7	−1.5	23.6	26.4	2.8
						RACELAND						
1940–42	24.8	24.9	0.1	25.6	28.2	2.6	30.5	26.5	−4.0	29.4	32.3	2.9
1941–43	25.2	24.6	−0.6	30.7	29.0	−1.7	23.4	32.1	8.7	29.6	32.2	2.6
Average	25.0	24.8	−0.2	28.2	28.6	0.4	27.0	29.3	2.3	29.5	32.3	2.8
						WESTOVER						
1941–43	31.7	29.1	−2.6	25.2	22.8	−2.4	24.0	27.2	3.2	19.3	22.4	3.1
1942–44	5.4	7.2	1.8	3.5	6.2	2.7	12.7	8.5	−4.2	12.1	7.1	−5.0
1943–45	26.8	29.7	2.9	27.6	27.0	−0.6	26.6	29.4	2.8	33.7	35.0	1.3
Average	21.3	22.0	0.7	18.8	18.7	−0.1	21.1	21.7	0.6	21.7	21.5	−0.2
Average*	19.1	19.3	0.2	19.3	20.6	1.3	20.7	22.4	1.7	20.1	21.8	1.7

*Average for six plantations.

TABLE 14. COMPARATIVE YIELDS OF PLANT AND FIRST YEAR STUBBLE CANE IN TONS PER ACRE AT CINCLARE PLANTATION, VARIETY CO. 281.

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
PLANT CANE												
1940–41	13.9	5.6	−8.3	24.1	27.4	3.3	31.7	31.7	0.0	35.7	31.4	−4.3
1941–42	20.0	18.9	−1.1	19.1	25.4	6.3	26.7	28.0	1.3	21.2	26.8	5.6
1942–43	6.9	4.3	−2.6	20.6	20.6	0.0	19.8	19.4	−0.4	15.8	18.2	2.4
1943–44	24.7	27.2	2.5	21.7	28.0	6.3	27.4	30.5	3.1	28.1	31.1	3.0
Average	16.4	14.0	−2.4	21.4	25.4	4.0	26.4	27.4	1.0	25.2	26.9	1.7
FIRST YEAR STUBBLE CANE												
1940–42	2.4	1.1	−1.3	5.6	7.4	1.8	8.5	8.7	0.2	11.6	10.8	−0.8
1941–43	6.2	4.4	−1.8	4.6	7.8	3.2	11.4	12.7	1.3	10.6	11.2	0.6
1943–45	13.4	14.8	1.4	17.8	19.6	1.8	19.8	20.0	0.2	15.1	18.7	3.6
Average	7.3	6.8	−0.5	9.3	11.6	2.3	13.2	13.8	0.6	12.4	13.6	1.2

TABLE 15. COMPARATIVE YIELDS OF PLANT AND FIRST YEAR STUBBLE CANE IN TONS PER ACRE IN PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED CANE ON TWO PLANTATIONS, VARIETY CO. 290.

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
PLANT CANE ALBANIA												
1940–41	16.8	14.7	−2.1	24.6	23.8	−0.8	9.4	12.7	3.3	23.7	29.8	6.1
1941–42	26.5	26.7	0.2	30.3	29.7	−0.6	25.1	29.2	4.1	32.0	29.9	−2.1
Average	21.7	20.7	−1.0	27.5	26.8	−0.7	17.3	21.0	3.7	27.9	29.9	2.0
BILLEAUD												
1940–41	29.2	32.6	3.3	33.1	34.6	1.5	35.7	36.4	0.7	37.1	35.4	−1.7
Average*	24.2	24.6	0.4	29.3	29.4	0.1	23.4	26.1	2.7	30.9	31.7	0.8
FIRST YEAR STUBBLE CANE ALBANIA												
1940–42	6.4	7.4	1.0	11.4	13.5	2.1	4.6	5.5	0.9	11.5	16.0	4.5
1941–43	26.5	25.7	−0.8	24.7	22.6	−2.1	23.4	23.7	0.3	23.1	24.8	1.7
Average	16.5	16.6	0.1	18.1	18.1	0.0	14.0	14.6	0.6	17.3	20.4	3.1

*Average for two plantations.

TABLE 16. COMPARATIVE YIELDS OF PLANT AND FIRST YEAR STUBBLE CANE IN TONS PER ACRE IN PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE ON TWO PLANTATIONS, VARIETY C.P. 29/103.

Year	August			September			October			November		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
PLANT CANE ALBANIA												
1942–43	29.6	27.8	−1.8	24.0	23.6	−0.4	21.6	27.4	5.8	17.4	29.5	12.1
1943–44	25.5	31.0	5.4	22.1	26.5	4.4	24.4	29.6	5.2	22.8	28.5	5.7
Average	27.6	29.4	1.8	23.1	25.1	2.0	23.0	28.5	5.5	20.1	29.0	8.9
GREENWOOD												
1942–43	41.2	40.9	−0.3	37.3	39.5	2.2	34.1	40.3	6.2	36.4	43.0	6.6
Average*	32.1	33.2	1.1	27.8	29.9	2.1	26.7	32.4	5.7	25.5	33.7	8.2
FIRST YEAR STUBBLE CANE ALBANIA												
1942–44	18.9	21.5	2.6	18.9	17.7	−1.2	19.8	22.1	2.3	18.0	28.0	10.0
1943–45	26.9	27.3	0.4	23.3	27.7	4.4	24.9	28.3	3.4	21.8	29.4	7.6
Average	22.9	24.4	1.5	21.1	2.27	1.6	22.4	25.2	2.8	19.9	28.7	8.8
GREENWOOD												
1942–44	35.5	32.9	−2.6	31.8	30.6	−1.2	33.1	32.7	−0.4	35.4	41.3	5.9
Average*	27.1	27.2	0.1	24.7	25.3	0.6	25.9	27.7	1.8	25.1	32.9	7.8

*Average for two plantations.

TABLE 17. COMPARATIVE YIELDS OF PLANT AND FIRST YEAR STUBBLE CANE IN TONS PER ACRE OF PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE AT BILLEAUD PLANTATION, VARIETY C.P. 29/116.

Year	August			September			October			November		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
PLANT CANE												
1941–42	43.9	35.9	−8.0	36.6	36.3	−0.3	33.4	32.9	−0.5	29.5	13.8	−15.7
1943–44	23.8	25.1	1.3	23.7	24.8	1.1	31.6	26.6	−5.0	24.5	21.3	−3.2
1944–45	....	....	....	17.1	20.1	3.0	23.3	24.6	1.3	....	....	....
Average	33.9	30.5	−3.4	25.8	27.1	1.3	29.4	28.0	−1.4	27.0	17.6	−9.4
FIRST YEAR STUBBLE CANE												
1941–43	28.3	26.5	− 1.8	34.2	34.4	0.2	18.9	18.3	−0.6	17.1	9.6	−7.5
1943–45	22.6	22.3	−0.3	29.7	27.0	−2.7	35.1	31.0	−4.1	32.3	21.5	−10.8
Average	25.5	24.4	−1.1	32.0	30.7	−1.3	27.0	24.7	−2.3	24.7	15.6	−9.1

TABLE 18. Comparative Yields of Plant and First Year Stubble Cane in Tons Per Acre of Hot-Water Treated and Untreated Seed Cane on Billeaud Plantation, Variety C.P. 29/120.

Year	*August*			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
Plant Cane												
1943–44	19.3	23.5	4.2	17.7	19.1	1.4	21.2	22.4	1.2	16.5	20.3	3.8
1944–45	....	....	....	14.1	15.4	1.3	17.5	22.6	5.1	....	....	....
Average	19.3	23.5	4.2	15.9	17.3	1.4	19.4	22.5	3.1	16.5	20.3	3.8
First Year Stubble Cane												
1943–45	19.5	22.0	2.5	23.8	22.2	−1.6	25.8	26.4	0.6	22.2	26.1	3.9

TABLE 19. Comparative Yields of 1944-45 Plant Cane in Tons Per Acre of Plots Planted With Hot-Water Treated and Untreated Seed Cane on Six Plantations, Variety C.P. 34/120.

	August			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
Albania												
	22.9	29.5	6.6	29.6	30.6	1.0	21.9	24.6	2.7	21.9	28.1	6.2
Cinclare												
	40.2	33.3	−6.9	38.8	39.1	0.3	34.2	36.2	2.0	36.5	39.0	2.5
Glenwood												
	18.4	21.8	3.4	30.6	35.4	4.8	35.6	37.8	2.2	....	....	....
Lower Terrebonne												
	28.5	25.8	−2.7	26.7	31.4	4.7	21.7	23.9	2.2	20.8	16.9	−3.9
Meeker												
	....	....	....	....	....	...	29.1	28.8	−0.3	....	....	....
Raceland												
	....	....	...	45.1	44.1	−1.0	47.6	48.5	0.9	38.8	47.8	9.0
Average	27.5	27.6	0.1	34.2	36.1	1.9	31.7	33.3	1.6	29.5	33.0	3.5

TABLE 20. COMPARATIVE YIELDS OF PLANT AND FIRST YEAR STUBBLE CANE OF PLOTS PLANTED WITH HOT-WATER TREATED AND UNTREATED SEED CANE ON VARIOUS PLANTATIONS, EIGHT VARIETIES

	August			*September*			*October*			*November*		
	Ch.	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*	*Ch.*	*Tr.*	*Diff.*
C.P. 29/320												
Plant	26.0	26.0	0.0	27.0	30.5	3.5	25.7	28.9	3.2	24.0	27.4	3.4
Stubble	19.8	20.3	0.5	21.3	23.2	1.9	21.6	23.2	1.6	21.9	23.7	1.8
			0.5			5.4			4.8			5.2
C.P. 28/19												
Plant	26.2	26.1	−0.1	26.1	28.6	2.5	24.5	26.9	2.4	23.6	26.4	2.8
Stubble	19.1	19.3	0.2	19.3	20.6	1.3	20.7	22.4	1.7	20.1	21.8	1.7
			0.1			3.8			4.1			4.5
C.P. 29/103												
Plant	32.1	33.2	1.1	27.8	29.9	2.1	26.7	32.4	5.7	25.5	33.7	8.2
Stubble	27.1	27.2	0.1	24.7	25.3	0.6	25.9	27.7	1.8	25.1	32.9	7.8
			1.2			2.7			7.5			16.0
Co. 281												
Plant	16.4	14.0	−2.4	21.4	25.4	4.0	26.4	27.4	1.0	25.2	26.9	1.7
Stubble	7.3	6.8	−0.5	9.3	11.6	2.3	13.2	13.8	0.6	12.4	13.6	1.2
			−2.9			6.3			1.6			2.9
Co. 290												
Plant	24.2	24.6	0.4	29.3	29.4	0.1	23.4	26.1	2.7	30.9	31.7	0.8
Stubble	16.5	16.6	0.1	18.1	18.1	0.0	14.0	14.6	0.6	17.3	20.4	3.1
			0.5			0.1			3.3			3.9
C.P. 34/120												
Plant	27.5	27.6	0.1	34.2	36.1	1.9	31.7	33.3	1.6	29.5	33.0	3.5
C.P. 29/116												
Plant	33.9	30.5	−3.4	25.8	27.1	1.3	29.4	28.0	−1.4	27.0	17.6	−9.4
Stubble	25.5	24.4	−1.1	32.0	30.7	−1.3	27.0	24.7	−2.3	24.7	15.6	−9.1
			−4.5			0.0			−3.7			−18.5
C.P. 29/120												
Plant	19.3	23.5	4.2	15.9	17.3	1.4	19.4	22.5	3.1	16.5	20.3	3.8
Stubble	19.5	22.0	2.5	23.8	22.2	−1.6	25.8	26.4	0.6	22.2	26.1	3.9
			6.7			−0.2			3.7			7.7

3b

LOUISIANA BULLETIN NO. 402 FEBRUARY, 1946

WEED INVESTIGATIONS

By

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AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATIONS
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WEED INVESTIGATIONS

CLAIR A. BROWN AND W. H. CARTER

I. THE WEED PROJECT

At the 1944 session of the Louisiana State Legislature, an appropriation was granted to the Louisiana Agricultural Experiment Station to make a study of the alligator weed and if possible to find measures for control or eradication. Recognizing the importance of the various weed problems in the State, the Louisiana State University assigned two members of the Faculty and Staff, one from the Department of Botany in the College of Arts and Sciences and one from the Department of Agricultural Engineering in the College of Agriculture to take charge of the investigations. By this arrangement, it was possible to use the funds from the special appropriation almost exclusively for equipment, supplies, travel and assistance. This arrangement also made it possible to consider to a certain extent some of the other pressing weed problems. This bulletin includes the results of the investigations of the two-year period with suggestions concerning urgent future work.

The necessity of investigations on weeds is becoming recognized more and more in various parts of the country. In many states, definite weed programs or projects have been set up and the investigations are being pushed as rapidly as possible. From these projects, there has already come much information of value. There is no reason why weed problems should not receive more serious consideration, and if they are given this consideration, there is a likelihood that satisfactory control measures will be found.

It has been estimated by the U. S. Chamber of Commerce that weeds cause an annual loss in this country of around $3,000,000,000. Other estimates have placed losses in individual states as high as $40,000,000 to $60,000,000 per annum. Such estimates seem reasonable and are probably not too high, especially since losses of many types occur which evidently have not been considered.

Weeds cause losses in various ways, the following being some of the more important:

(a) The extra expense of cultivating agricultural crops due to weeds ranges ordinarily from $3 to $10 per acre, depending on the crop and the locality. Even using the low figure of $3, this would mean in Louisiana on 10,000,000 acres of agricultural land a loss of $30,000,000 per year.

(b) Weeds growing in competition with crop plants, use up the available mineral nutrients and soil water and cause a loss in yield. While such reductions in yield are sometimes negligible, quite often they are very large. Johnson grass in sugarcane fields may be responsible for reductions in yield of 50 per cent or more.

(c) The weed-seed mixtures in grains such as wheat and rice are responsible for heavy losses. The dockage of wheat at the grain elevators in Canada for one year included over 270,000,000 pounds of weed seed, or 2.08 per cent of the crop and represented a dockage of $29,000,000. A similar condition exists with rice. A deduction of 15 cents per barrel due to the presence of weed seed would represent for this year, a loss of $959,500.00. The expense of removing weed seed from grain and other seeds is large.

(d) Depreciation in land values follows heavy infestation with such weeds as Johnson grass and alligator weed.

(e) Weeds such as water hyacinth and alligator weed clog up bayous and lakes, interfering with navigation and causing other troubles.

(f) Many weeds harbor plant diseases and insect pests that can pass to cultivated crops.

(g) Poisonous fungi occur on a few weeds, for example, ergot on Dallis grass.

(h) Many weeds are poisonous or allergic to certain persons; for example, poison ivy (skin troubles) and ragweeds (hayfever).

(i) Certain weeds impart a bad flavor to milk; for example, wild onions.

There has been increased interest in weed control during the past year, due largely to the publicity given the "so-called" hormone weed killers or 2,4-D compounds. These compounds show considerable promise, and they should be thoroughly investigated. However, it also seems important at this time to include all of the weed problems in a general weed project.

As seen at the present time, this project would lead eventually to the preparation of a manual on the weeds of the State which would be put into the hands of all interested, including the children in the schools. Information would also be gradually obtained on methods of control.

II. THE ALLIGATOR WEED INVESTIGATION

The alligator weed, which is normally an inhabitant of the waterways, invaded crop lands about two decades ago and has now become a serious weed in some of the sugarcane, rice and truck crop areas of Southern Louisiana. Unless this pest is checked, crop production will be materially affected, and land value of heavily infested areas will show a marked reduction. The alligator weed competes with the growing crop for moisture, soil nutrients, and fertilizers, thus causing a reduction in yield. It increases the cost of production because additional cultivation is necessary.

Names

The alligator weed has a variety of other common names, such as bayou grass, water grass and alligator grass. The name alligator weed is preferable because the plant is not a grass. The scientific names likewise are numerous. It was originally described as *Telanthera philoxeroides,* but later when the genus *Telanthera* was divided, this species was placed in the genus *Alternanthera.* The recent manuals have placed it in the genera *Alternanthera* and *Achyrantha.* The name more generally accepted is *Alternanthera philoxeroides* (Mart.) Griesb.

History

This plant, a native of tropical America, was first described from Brazil in 1826. It was discovered in Florida in 1894. Charles Mohr found it near Mobile, Alabama, in 1897, and noted that it completely filled the stream. R. S. Cocks found it in the vicinity of New Orleans in 1898. The following quotation from Cocks emphasizes the relative abundance of the plant at that time: "I have found three species in Louisiana, all of them in the vicinity of New Orleans. The first one, *Telanthera maritima,* which can be distinguished by its blunt leaves and short peduncle, deserves notice, for it shows some tendency to rival the celebrated water hyacinth [*Piaropus crassipes*] in choking up our bayous. There is a canal near Milneburg, which during the summer was completely filled by it."

An examination of Cocks' specimens of *Telanthera maritima* reveal that it is the blunt-leaved form of *Alternanthera philoxeroides.*

Just how long the alligator weed has been in Louisiana is not known. Its present distribution in the State seems to justify the belief that it was not present many years before Cocks found it.

Previous Studies on Alligator Weed

Very little work has been done on this pest. Over a period of 18 years several sporadic attempts to study this plant were started by students at Louisiana State University. The first illustration of the alligator weed in the United States was one included in an article published in the Conservation Review of 1935, by C. A. Brown. Attention at that time was directed to the obnoxious characteristics of the plant. W. T. Penfound and T. F. Hall of Tulane University also published a brief account of the biology and anatomy of the plant. George Arceneaux and Leo Hebert of the U. S. Sugar Experiment Station at Houma published some figures to give the abundance of alligator weed and later advocated the use of the flame cultivator for its eradication.

The alligator weed has been practically eliminated from the TVA localities by the use of larvacidal oil, a mixture of nine parts kerosene and one part black oil, applied at the rate of 800 to 900 gallons per acre. It is believed that in the early stage of invasion, the results justified the high cost.

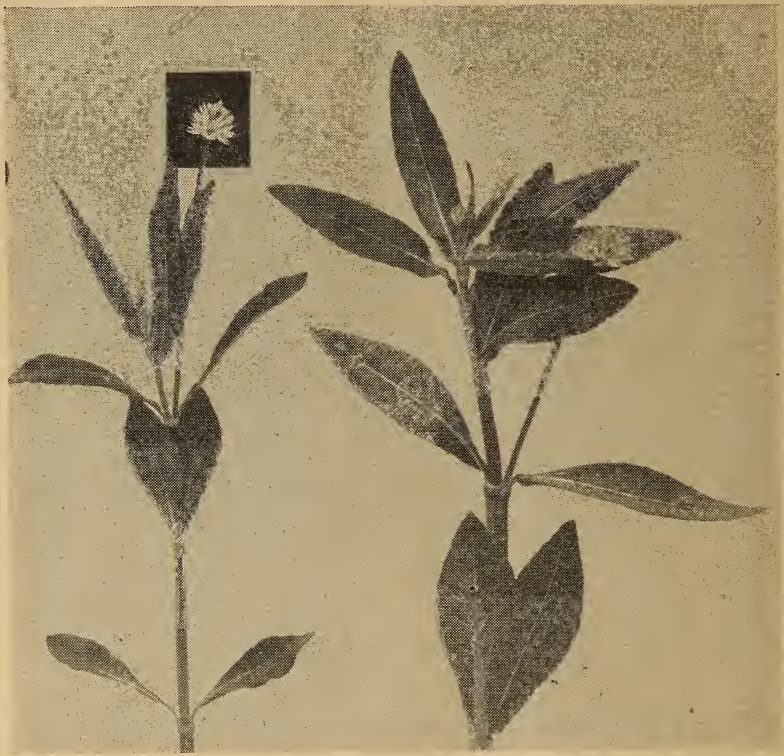

FIGURE 1. Alligator weed.

Distribution of Alligator Weed

This plant has been found in the Southern United States from Texas to Florida and northward along the Atlantic seaboard into the Carolinas. It has been found inland in Northern Alabama in the Tennessee Valley.

In Louisiana, it occurs in every parish in the southern portion of the State, either in the major streams, or in ditches and cultivated fields. At the present time it is absent from a portion of the Atchafalaya Basin, namely the upper end of Grand Lake, Bayou Pigeon, Chicot Pass, Bayou Sorrel and Bayou Corne. There is a trace in Point Coupee Parish, and in a roadside ditch at Mansura, Avoyelles Parish. It is reported as common in a number of small lakes near Hamburg. Likewise, only a trace occurs around the shores of Lake St. John in Madison and Tensas Parishes, although Bayou L'Argent which empties into Lake St. John is completely filled from bank to bank.

Alligator weed is intolerant to salt water and is in general absent from the saline marshes. Small amounts occur in roadside pools below Golden Meadows and in pools on Grand Isle which have essentially fresh water.

Description of Plant

The alligator weed (Figure 1) has fleshy storage roots up to $\frac{1}{2}$ inch in diameter. These roots are whitish and lack nodes. Just under the surface of the ground are reddish stems (rhizomes) which have nodes from which grow either fine fibrous roots or the storage roots. Above the ground the plant produces green stems made up of nodes and internodes with a pair of leaves at each node. These stem nodes are capable of producing fine roots and aerial stems. A given plant may produce several stems which spread out over the ground early in the season. As the grasses and other plants crowd it and increase in height, the alligator weed sends up shoots from the procumbent stems, which may attain a height of five feet. In water, the vine-like semifloating stems extend 15 to 25 feet away from the bank. These branch and rebranch, and send out upright shoots from the nodes and in time form a dense mat. Occasionally these mats break loose from the shore and form floating islands.

The leaves are very variable in shape and size, depending upon the habitat and the season of the year. Collections from rapidly flowing water in early spring have large succulent leaves, broadly elliptic to obovate and two to four inches long. Late summer collections from the same spot will have leaves obovate and $1\frac{1}{2}$ inches long. The reduction in size of leaves between early spring and late summer is very noticeable. Collections from the brackish areas around Lake Pontchartrain usually have obovate leaves $\frac{3}{4}$ to $1\frac{1}{4}$ inches long. The acute-leaved form of the plant is common in cultivated ground and has been described as a variety. Experiments, however, indicate that it is just a growth form. Some plants have been found which have acute leaves at the apex and obtuse leaves lower down on the stem.

The flowers are produced in heads which have been aptly characterized as "clover-like." The individual flower consists of three bracts, subtending five sepals, all of which are white and tough. These enclose five stamens alternating with five staminodia, all on a common filament sheath around the ovary. The ovary has a relatively long style and capitate stigma. It is one-celled and one-ovuled. Occasional fruits have been found which are distinctly heart-shaped. These did not contain mature seeds.

Method of Spread

The plant does not normally produce seed, thus its spread in the waterways and cultivated fields is by fragmentation of the stems and roots. Each node, even when cut down to $\frac{1}{8}$ of an inch in length, will start a new plant. Pieces of the storage roots $\frac{1}{2}$ inch long will produce new shoots. The more the roots are cut up, the more new shoots there will be (Figure 2).

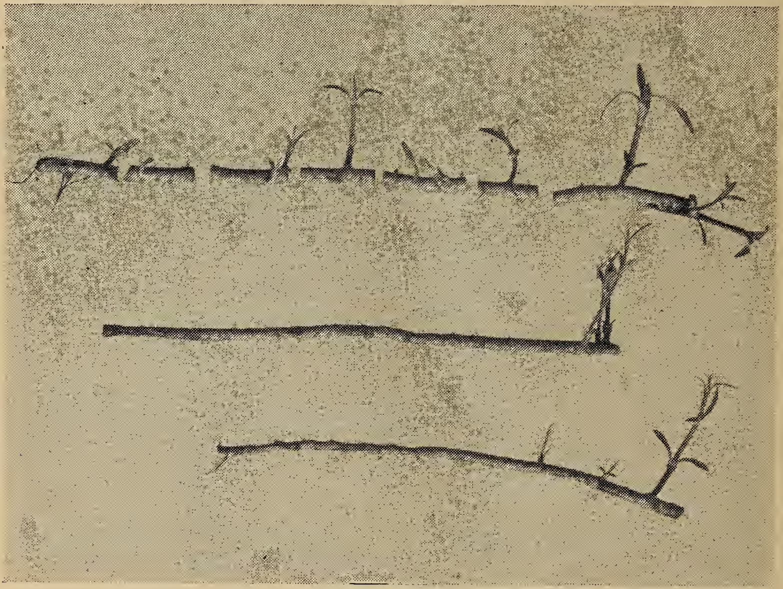

FIGURE 2. Alligator weed roots showing production of shoots from segments. Segments in top row are all from one root.

The alligator weed has spread from the bayous into ditches, up the ditches and into cultivated fields. In cleaning the ditches the plant is often thrown up on the cultivated ground. Farm machinery carrying mud with alligator weed embedded in it has distributed the plant into other fields. The use of a suction dredge in streams containing alligator weed has resulted in an infestation of lands where the soil was deposited. Floods have undoubtedly aided in the dispersal of the plant.

Investigations on Control Measures

Various types of control measures have been used at one time or another to control weeds. In the investigations on the alligator weed in

Louisiana, most attenttion has been paid to control by toxic chemicals and control by cultivation methods. When the work started, these seemed the most promising. The results which have been obtained are very encouraging.

Chemical Control Studies

During the past quarter of a century, chemicals have been used to a certain extent to destroy weeds. Two types of materials have been used, or are available for weed control work.

(a) Chemical weed killers, substances which kill the portions of the plant on which they are placed.

(b) Hormone weed killers, substances that are absorbed by the leaves or stems and transported to other parts of the plant.

In the work with the alligator weed, it seemed important to try as many substances as possible of both types. The efficiency of weed killers depends upon the plant, soil type, rainfall, temperature, season of application and other conditions.

Work With Chemical Weed Killers

The following is a list of chemical weed killers which have been tested on alligator weed on plots 100 sq. ft. in size, or on rows, at Woodlawn Plantation, Napoleonville, and at Baton Rouge, Louisiana:

Ammate—ammonium sulfamate
Ammonium sulphate
Ammonium thiocyanate plus tractor fuel
Atlas A—an arsenical compound
Atlascide—a chlorate mixture (powder)
Beneclor
Borax
Cardox chlorate (liquid)
Chloropicrin
Copper chloride
Copper sulphate
D-D—a dichloropropylene propane mixture
Dow Contact herbicide 502
Dow Selective herbicide 506
Ferric sulphate
Ferric sulphate plus sulphuric acid
Ferrous sulphate
Hammond weed killer
O.S.S.
Puratized N5D, 1/2 MC, 804
Santobrite
Santophene
Sinox (Sodium dinitro ortho cresylate)
Sinox powder (Dinitro ortho cresol)

Trichlorobutane
Velsicol "K"

The most promising chemicals of the above list seemed to be borax, ammate, and chlorates. However, there are certain disadvantages connected with their use, such as high cost per acre, partial soil sterility, and inflammability. If it were not for the recent discovery of the groups of compounds now designated as hormone weed killers, it would be necessary to concentrate on these and certain oil compounds not yet tried.

Work with Hormone Weed Killers

That some of the compounds known as hormones might be important in killing weeds was first brought to the attention of the public by a note in *Science* in August, 1944. In this note, it was stated that one of these compounds would kill the European bindweed, a pest notoriously difficult to eradicate. This report gave encouragement to the fight on weeds and has stimulated much research on weed control.

The basic chemicals in hormone weed killers are 2,4 dichlorophenoxyacetic acid and 2,4,5 trichlorophenoxyacetic acid. The former is commonly known as 2,4-D. These chemicals are taken up by the plants and in very dilute concentrations often stimulate the growth of plants. At higher concentrations, however, they gradually kill the plant tissues.

These compounds are used to kill weeds at concentrations of 1,000 parts per million or 0.1%, or at the rate of 15 ounces per hundred gallons of water per acre. Most companies supplying these compounds suggest 1 to 1½ pounds per 100 gallons of the solution per acre. In spite of the relatively high cost per pound, the cost per acre is much lower than that of any of the chemical weed killers mentioned above. The cost for these compounds will vary from $1.50 to $4.50 per acre and up, depending upon the concentration used, the manufacturer, the size of the package, and whether used as a powder, liquid or in tablet form.

At present, 66 substituted phenoxy compounds are known. The following have been tested for their ability to kill alligator weed in Louisiana, and in the course of the experiments, have been tried on many other weeds:

2,4 dichlorophenoxyacetic acid (2,4-D)
2,4,5 trichlorophenoxyacetic acid (TCP)
P-chlorophenoxyacetic acid (P-Chlor)
Monochloroacetic acid
2,4 dichlorophenoxyacetamide (HL4)
Sodium salt of 2,4 dichlorophenoxyacetic acid (Na-2,4-D)
Ethyl acetate of 2,4-dichlorophenoxyacetic acid
Dupont IN-4311-A9, 72% 2,4-D plus a dispersing agent

Dupont IN-6065, ammonium 2,4-dichlorophenoxyacetate
Dupont IN-6065-A9, ammonium 2,4-dichlorophenoxyacetate and ammonium sulfamate
2,4-Dow Weed Killer powder form, 70% sodium salt of 2,4-D
Weedone, originally described as 10% solution of 2,4-D, now listed as 10% TCP
Weedone No. 4, 9% solution of 2,4-D
4-chloro-2-toloxyacetic acid
2,4-D in Velsicol

Pure 2,4-D is not soluble in water and must be dissolved in a carrier, such as Carbowax 1500, cyclohexanone, or Velsicol.

Action of 2,4-D Compounds on Alligator Weed

About 18 to 24 hours after applying sprays containing 2,4-D, the alligator weed appears slightly wilted. Wilting increases until the stems are flat on the ground, and the leaves become limp. Tips of stems become twisted, leaves turn yellowish, and finally drop off. The nodes swell, the stems become very brittle and readily break at the swollen nodes. Root-like galls develop on the internodes. After a period of 2 to 3 months most of the stems are dead. The action on the underground parts appears to be slower, but eventually there is a partial deterioration of the root system (Figure 3).

The slowness of action of 2,4-D compounds can best be illustrated by an experiment made at Woodlawn Plantation near Napoleonville. Three aqueous mixtures were prepared; two from a Dow product mixed at rates of 32 grams and 50 grams per five gallons and one from a Dupont product, IN-4311-A9, mixed at rate of 30 grams per five gallons. On July 5, 1945, each of these was sprayed on two rows approximately 100 feet long in a sugarcane field. These rows were badly infested with alligator weed. At intervals during the summer, these rows were examined and the condition of the alligator weed was noted. The notations were as follows:

July 8. Alligator weed wilted, partially collapsed, stems twisted, few of the leaves starting to turn yellow.

August 1. Alligator weed stems leafless, some dead, a small per cent still alive. Procumbent stems with swollen nodes.

September 12. Rows grassy, alligator weed difficult to find. One row with only two sprigs, others with as many as 25 sprigs.

October 15. Rows grassy. On rows sprayed with Dow 32 grams, 147 and 241 sprigs; on rows with Dow 50 grams, 68 and 64 sprigs; and on rows with Dupont 30 grams, 51 and 21 sprigs. The unsprayed rows had so many sprigs of alligator weed that it was impossible to count them. It was estimated that there were 700 to 1000 sprigs per row.

November 11. No appreciable increase of alligator weed over previous date.

The alligator weed was not eradicated in this or in other tests that were made in sugarcane fields, but the percentage of kill was very large.

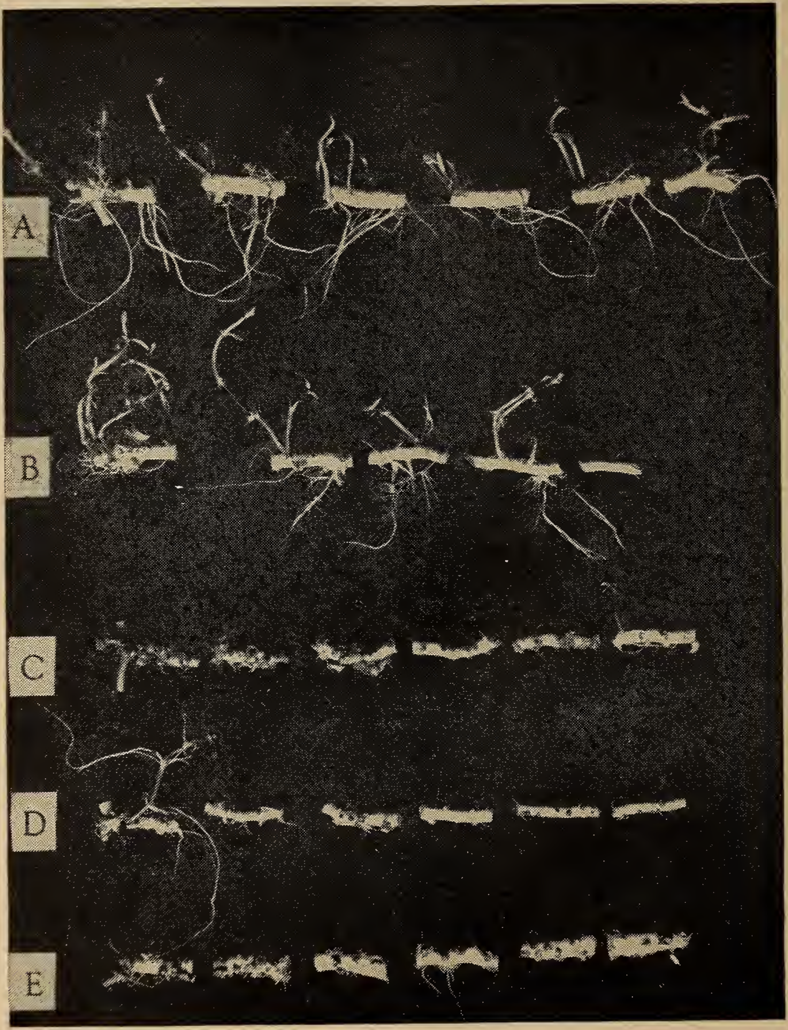

FIGURE 3. Production of shoots from segments of alligator roots after treatment with 2,4-D compounds. A. Control, not treated. B. Treated with P-chlorophenoxyacetic acid. C. Treated with Dow weed killer. D, E. Treated with sodium salt of 2,4-D, product of Niagara Sprayer Company.

Not only were the tops killed, but the roots were also injured or weakened. The effectiveness of any chemical for the control of alligator weed does not depend so much on killing the tops as it does on the injury to the root system. In the tests with 2,4-D, many roots were destroyed and the others were so weakened that regrowth from them was delayed. The young shoots which were finally produced from the weakened roots were spindling and at first grew much more slowly than normal plants. In time these plants became more vigorous and apparently showed more or less normal growth. The lapse of time, however, between the application of the spray and the time regrowth occurs seems to be important in testing the effectiveness of the chemical.

Sugarcane stalks from the sprayed rows were cut and the juice analyzed. There was no evidence that the 2,4-D compounds had any effect on the sucrose or purity of the juice and there was nothing to indicate that the yield of cane was decreased. This agrees with results recently reported by Arceneaux and his co-workers, with the exception that they found that cane was injured slightly by heavy applications of 2,4-D.

One of the striking results of all the tests made in the sugarcane fields with 2,4-D was the general killing of many of the common weeds, with the exception of the true grasses. The contrast between the sprayed and check due to the almost total absence of "milkweed" or wild poinsettia in the sprayed rows was astonishing. There was also some reduction in the quantity of grasses on some of the treated rows. Later tests indicated that while grass plants of some size did not seem to be injured, these compounds did inhibit seed germinatiton and in some cases caused injury to small grass seedlings 2 to 3 inches high.

Several applications of the 2,4-D compounds were made just prior to heavy rains, and in three instances rain fell before the spraying was completed. As nearly as could be determined, the injury to alligator weed was as severe as on rows treated during sunny dry weather. This is an important item to anyone starting a spray program.

The results of treating alligator weed growing in water were not as satisfactory as were those on plants growing in soil.

Several tests made with 2,4-D compounds indicate that they are inactive or at least less active at temperatures below 50°F. This might be expected because all functions of plants are reduced at low temperature.

Better results were also obtained with 2,4-D when it was applied with a power sprayer with a pressure of 125 to 150 pounds than when applied with a low pressure garden sprayer. With high pressures, better coverage was obtained with less spray material.

The results obtained with 2,4-D compounds are very interesting and it is believed that these compounds will eventually have a place in alligator weed control. Much, however, remains to be done in regard to equipment, time of application, amount of material to be used, the number of applications and relative effectiveness of the different products. It may also be found that more effective control can be obtained by combining spraying with certain cultivation practices.

Machinery Control Studies

This phase of the work dealt with the use of farm machinery for the control of alligator weed. The machines used were those commonly found on the farm or ones that can be purchased from the manufacturer. No alterations, other than adjustments provided by the manufacturer, were made.

A number of plots of approximately 0.4 acres each, were selected on Woodlawn Plantation at Napoleonville, Louisiana. This area represented the heaviest infestation of alligator weed. These plots were not in cane rows, thus permitting all operations to be performed on flat land.

A system of fallow cultivation was followed on the several plots. Below are listed the operations and combinations of operations performed on single plots at intervals as indicated.

1. Mowed with field mower at weekly intervals.
2. Plowed with moldboard plow as weed growth demanded.
3. Disked with tandem disk at weekly intervals.
4. Burned with Woolery burner moving at 2 miles per hour at weekly intervals.
5. Burned with Woolery burner moving at 4 miles per hour at weekly intervals.
6. Cultivated with field cultivator at weekly intervals.
7. Burned before cultivation with field cultivator, all cultivating operations done at weekly intervals.

Actual field work was begun October 1944 and was carried through August 1945.

The following paragraphs summarize the results as nearly as they can be evaluated at this time.

1. *Mowing.* This operation held back top growth but did not reduce infestation of alligator weed.

2. *Plowing.* Plowing or flat breaking gave temporary control of alligator weed. This plot was plowed five times. This is the most costly tillage operation, and the area covered in a given time is limited by the power required. Plowing is less effective than other tillage operations in reducing root concentration in the soil. While a few exposed pieces dry and die, regrowth may be expected from those pieces of live roots still incorporated in the soil.

3. *Disk Harrowing.* Disking with tandem disk appeared to give temporary control. This operation was performed sixteen times. After ceasing operations, however, regrowth of alligator weed become as heavy as the growth at the beginning of the tests. The action of the disk cuts the weed stems and roots into small pieces. Since new plants may be started from nodes along the stem or from root pieces as short as $\frac{1}{2}$ inch in length, the decrease of infestation from those dying is offset by new plants started from pieces cut and scattered by the disk.

4-5. *Burning.* The flame cultivator has now had three seasons of use as a tool for combating alligator weed. While this has been an effective control tool for some purposes, it has not been effective in controlling the alligator weed. These plots were burned sixteen times, one plot at 2 miles per hour and a second at 4 miles per hour. Top growth was held back, but there was no reduction in the root infestation. It was found that burning encouraged stooling out of the plant as illustrated in figure 4. After allowing time for regrowth, the top growth was more dense than when the tests began. No difference in effect was observed in the two treatments.

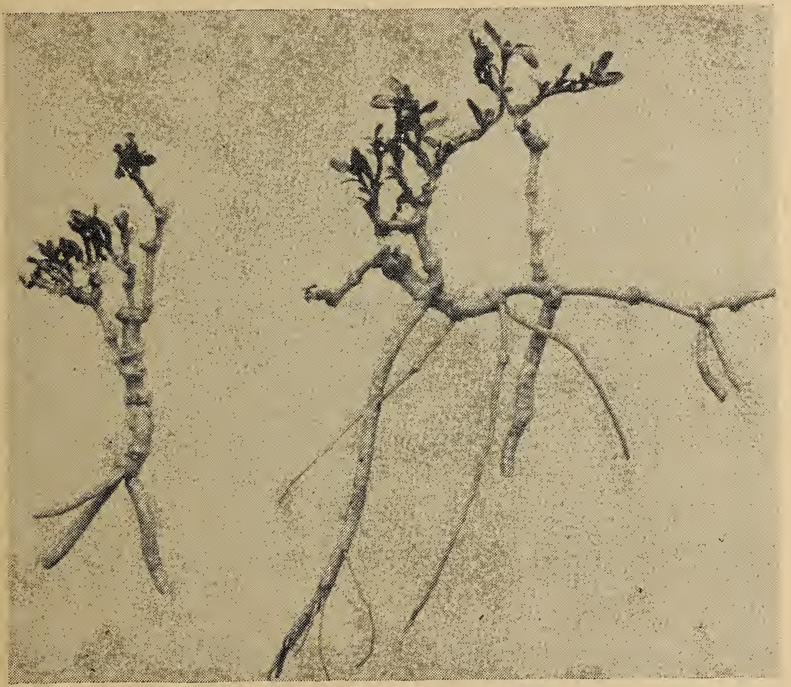

FIGURE 4. Alligator weeds from a field burned 16 times at weekly intervals. The burning increased shoot development and apparently had no effect on the roots.

In order to test whether or not alligator weed could be killed with flame, a small area 10 ft. x 20 ft. was heated until the soil under the burner nozzle reached a dull red color and until all plant residues were completely burned. Two weeks after this operation, new sprigs of alligator weed made their appearance. This intensity of burning would not be feasible on a large area, even if the alligator weed were killed. The total amount of oil burned for the sixteen operations was at the rate of 360 gallons per acre. It appears now that more disastrous effects on the alligator weed might have been accomplished had all the oil been applied at one time as a liquid spray.

The machine used for these burning tests is shown in figure 5.

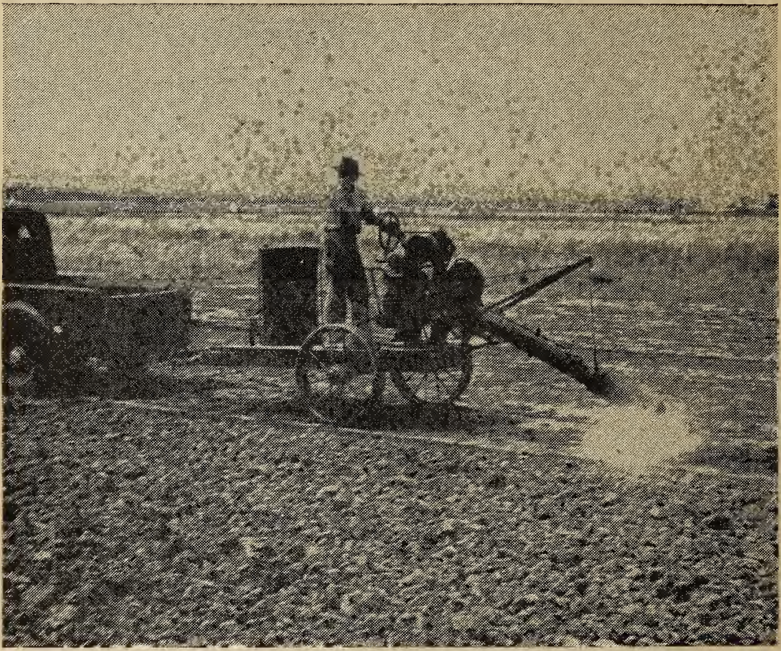

FIGURE 5. The Woolery burner in action.

6. *Field Cultivating.* The field cultivator was most effective in reducing alligator weed infestation. After seventeen operations only scattered plants could be found. This machine was equipped with 8 inch duck foot type shovels for soil stirring. Since these shovels were mounted on spring teeth, the effect was to lift out the roots and bounce them to the surface where they were left to dry and die. The infestation was light after cultivation because the roots were actually removed from the soil at least to a depth of 7 inches. The draft of this machine is less than that of a moldboard plow, thus permitting a wider machine to be pulled behind a given size tractor. When using a 6 foot machine behind a

3-plow tractor, the total cost per "once over" acre is approximately $.60. It is believed that equal control could be secured with less frequent operations, say ten, thus making the cost around $6.00 per acre.

This machine has been used with success in other states for the control and eradication of noxious weeds, such as the bindweed. Reports indicate that the cost for eradication fell between $10.00 and $12.00 per acre.

It will also be of interest to know that the field cultivator is an effective tool for the eradication of Johnson grass. A heavily infested field on Woodlawn Plantation was completely cleared of Johnson grass during the summer of 1945. The field was first flush plowed to level the land and reduce crop and weed residues on the surface. After a short delay for settling and drying, the field cultivator operations were begun. Fourteen "once over" operations were performed with the field cultivator. The direction of each succeeding operation was at right angles to the previous operation and during favorable growing weather the operation was performed twice weekly. Figure 6 shows this machine at work in one of the plots at Woodlawn Plantation.

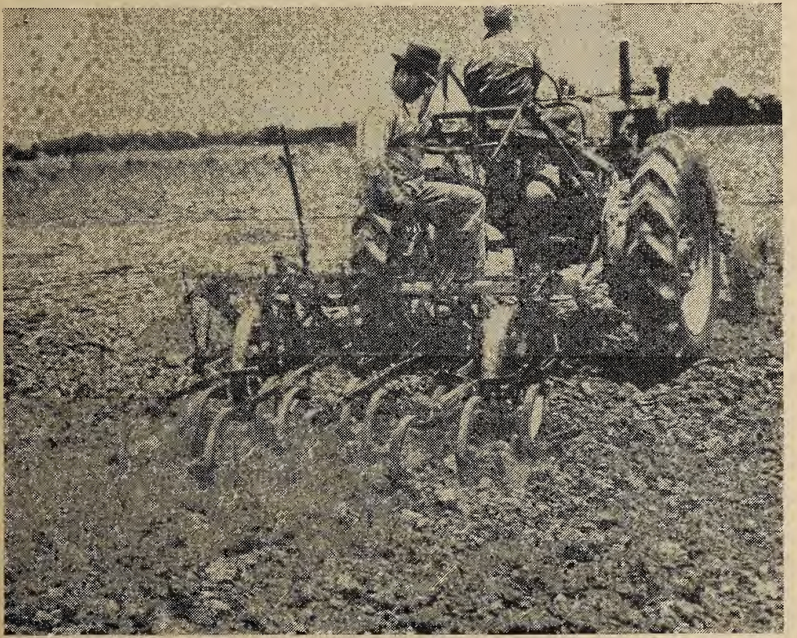

FIGURE 6. The field cultivator materially reduced the quantity of alligator weed.

7. *Burning before Cultivating.* When there was considerable top growth at the beginning of the tests, killing the tops back by flame a

few hours before cultivating was found very effective. On this plot the top growth was such that burning was necessary only before the first and third cultivations; after that the top growth was not enough to warrant burning. After seventeen cultivations only scattered plants could be found in this plot. Again the reduction was brought about by bringing the roots to the surface. Each burning operation adds approximately $3.50 per acre to the cost of control.

It must be recognized that the weather plays an important part in all fallow cultivation operations. During these tests, all operations were performed as planned. Prolonged periods of rain undoubtedly would have altered the results. Laboratory tests show that two weeks of drying weather are required to kill the alligator weed root. A period of this length does not occur frequently in Louisiana.

The question may be raised as to why all machinery studies were performed on flat land, rather than having some on cane rows. The practice of flush plowing all cane lands when taken out of cane during the rotation seems to be increasing. Flush plowing towards the center of each cut gradually raises the elevation of the center of the cut, reduces the height of ridges along each drainage ditch, makes shallower quarter drains, and improves drainage in general. Since more or less special machines would be required for studies on cane rows, it is believed that the advantages of plowing justify the operation and at the same time provide more favorable field conditions for a weed eradication program.

Machinery Studies Needed

After August 1945, frequent rains prevented further field studies of any consequence. It is believed that studies of the following nature should be conducted:

1. Field cultivating at two-weeks intervals. If this frequency proves as effective as weekly cultivations the cost would be materially reduced.
2. Field trials with a commercial weed eradicating machine known as the "Tigerman."
3. Field trials with the rotary terracing machine in an attempt to loosen the roots so that they can be raked out and removed from the land.
4. Exposure of roots to flame after being brought to the surface by the field cultivator.
5. Spraying followed by plowing; one plot plowed the same day as spraying and a second plot plowed one week after spraying.
6. Field cultivator followed by a spray; one plot cultivated and sprayed the same day, and a second plot sprayed one week after cultivation.

Observations of plot treatments of last year should be continued through another.

III. EFFECT OF 2,4-D ON OTHER PLANTS

In the short period of time that has elapsed since the properties of the 2,4-D compounds were recognized, it has not been possible to test them on many plants. Numerous inquiries have been received asking for information on how they affect palmetto, Johnson grass, teaweed, Bermuda grass, and various crop plants such as cotton and sweet potatoes. As most of these questions could not be answered, tests were made with many of the common plants. In small scale tests, the following plants were readily killed by 2,4-D compounds:

Carpet grass, *Axonopus compressus* (Sw.) Beav.
Cherokee rose, *Rosa laevigata* Michx.
Chickasaw rose, *Rosa bracteata* Wendl.
Chinese tallow tree, *Sapium sebiferum* (L.) Roxb.
Cocklebur, *Xanthium americanum* Walt.
Coco grass, *Cyperus rotundus* L.
Corn spurry, *Spergula arvensis* L.
Daisy fleabane, *Erigeron philadelphicus* L.
Dayflower, bat wing or turtle back, *Commelina* spp.
Giant ragweed, *Ambrosia trifidia* L.
Indigo, *Sesbania macrocarpa* Muhl.
Lesser ragweed, *Ambrosia artemisiaefolia* L.
Milkweed or poinsettia, *Poinsettia dentata* (Michx.) Small.
Mule-ear, *Heteranthera limosa* (Sw.) Willd.
Pennywort or dollargrass, *Hydrocotyle umbellata* L.
Peppervine, *Ampelopsis arborea* (L.) Rusby.
Pigweeds, *Amaranthus* sp.
Poison-ivy, *Rhus radicans* L.
Redweed, *Melochia corchorifolia* L.
Roughleaved marshelder, *Iva ciliata* Willd.
Tievine, *Thyella tamnifolia* (L.) Raf.
Toothcups, *Ammania coccinea* Rottb.
Yaupon, *Ilex vomitoria* Ait.
Yellow sedge, *Cyperus iria* L.
Willow, *Salix nigra* Marsh.

The results on the following plants were not always consistent. Sometimes the plants were killed, sometimes only injured, and frequently they put out new growth after treatment. A high percentage of kill was obtained with certain ones:

African daisy, *Helianthus* sp.
Blackberry, *Rubus* sp.

Chickasaw plum, sprouts, *Prunus angustifolia* Marsh.
Cordate-leaved peppervine, *Ampelopsis cordata* Michx.
Creeping spurge, *Chamaesyce* sp.
Crowfoot or goose grass, *Eleusine indica* (L.) Gaertn.
Curly dock, *Rumex crispus* L.
Eclipta, *Eclipta alba* (L.) Hassk.
Elephant ear, *Colocasia* sp.
Elderberry, *Sambucus canadensis* L.
False garlic, *Nothoscordium bivalve* (L.) Britton; *Nothoscordium fragrans* (Vent.) Kunth.
Goatweed, *Croton capitatus* Michx.
Goldenrod, *Solidago altissima* L.
Gymnostyles, *Gymnostyles nasturtiifolia* Juss.
Horse-nettle, *Solanum carolinense* L.
Japanese honeysuckle, *Lonicera japonica* Thunb.
Maypop, *Passiflora incarnata* L.
Mazus, *Mazus japonicus* (Thunb.) Kuntze.
Mexican weed, *Caperonia castaneaefolia* (L.) St. Hil.
Nightshade, *Solanum nigrum* L.
Partridge pea, *Chamaecrista fasciculata* (Michx.) Greene.
Primrose jasmine, *Jasminum primulinum* Hemsl.
Roughleaf dogwood, *Cornus drummondii* Meyer.
Silvery or curly indigo, *Aeschynomene virginica* (L.) B.S.P.
Smartweed, *Persicaria* spp.
Spiny thistle, *Cirsium horridulum* Michx.
Teaweed, *Sida* spp.
Tung-oil tree, *Aleurites fordii* Hemsl.
Verbena, *Verbena littoralis* H.B.K.
Water hyacinth, *Piaropus crassipes* (Mart.) Britton.
Waxmyrtle, *Myrica cerifera* L.
Wild onion, *Allium canadense* L.
Winged loosestrife, *Lythrum alatum* Pursh.
Yankee-weed, *Eupatorium capillifolium* (Lam.) Small.

Coco Grass

Coco grass has long been recoznized as a serious pest, and at one time in the 1840's the State Legislature offered a large reward for a method of eradication.

About a week to 10 days after coco grass was sprayed with 2,4-D, a yellowing of the foliage became evident, and in time the leaves died without the usual wilting symptoms.

When a plant showing the yellow leaves was grasped at the soil level and gently pulled, the top came out of the ground easily. It usually broke near the top of the tuber and the tissues were found to be discolored and, in an advanced stage, rotten. The tubers were either completely discolored and watersoaked within, or were discolored only at the apex. The absence of coco grass tops in sprayed plots 10 to 14 weeks after treatment was very noticeable. When the soil was turned over, dormant tubers often produced plants.

In flower beds or around shrubbery, 2,4-D should not be used unless one is prepared to accept the accidental killing of some desired plant.

Rice Weeds

It is customary for the rice farmers to hand pull indigo at a cost of around $2.50 per acre. Not only do indigo and other weeds reduce the yields of rice, but weed seeds in threshed and milled rice reduce values. Before the war, the presence of three seeds of indigo, curly indigo, or bat wing per pound in cleaned rice resulted in a reduction of 10 cents per barrel. If the number ran as much as 8 to 15 per pound the deduction was 35 cents per barrel. When Mexican weed seed reached about 2 per cent a deduction of 5 to 10 cents per barrel was made. Deductions for alligator head, a plant different from alligator weed, and turtle back seed varied from 10 to 35 cents.

Preliminary treatments demonstrated that 2,4-D compounds would kill indigo, redweed, mule ear, and several sedges easily. The action on curly indigo and Mexican weed was not so satisfactory. Rice plants a foot high and older plants just prior to heading did not seem to be injured. Part of the variation in the killing of curly indigo and Mexican weed was due to the difference in wetting of the foliage with spray solutions. The low cost per acre of spray materials suggest that spraying or dusting rice fields will be economically possible. The tests were made at the rates of 6, 12, and 14 ounces per 100 gallons per acre. In general, best results on relatively large plants were obtained at 12 and 14 ounces per acre. Lower concentrations could probably be used on smaller and younger plants.

A slight stunting (Figure 7) was noted on seedling rice grown in pots in the greenhouse at Baton Rouge. Considerable work remains to be done on time of application, rate, addition of spreaders and stickers. The cost per acre of spray materials with one of the 2,4-D compounds selling at $3.00 per pound may vary from $1.50 to $2.50 per acre. It may be found that airplane dusting will be feasible, and if so this would doubtless be much less costly.

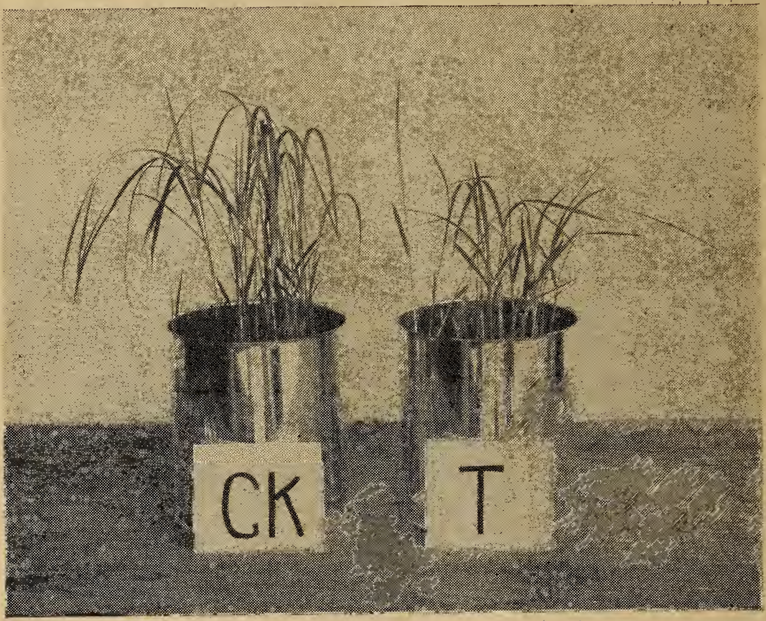

FIGURE 7. Effect of sodium salt of 2,4-D on young rice plants. Plants on right (T) treated with compound, plants on left (CK) untreated.

Cocklebur Succumbs

Cocklebur sprayed prior to flowering succumbed to 2,4-D. Large acreages of the State are either flooded occasionally or subject to overflow each year. Cocklebur is one of the main pests following the receding waters. The destruction of cockleburs would materially improve crop production and pasture lands for live stock.

Ragweeds Die

Two of the most important hayfever plants, namely the giant ragweed and the lesser ragweed, were readily killed by 2,4-D compounds, even when the plants were three or four feet tall. Spraying just before the flowers opened was not as effective in killing the plants as earlier applications. It is estimated that 10 per cent of the population suffers from hayfever. The treatment of vacant lots and roadsides would not only kill many objectional weeds, but also should give considerable relief to the hayfever sufferers.

Rosebriar Killed

The chickasaw and cherokee roses are two introduced roses which have escaped from cultivation and have become so thoroughly naturalized that most people think of them as native plants. In some sections of the State, these plants are so numerous that considerable areas of the land lie idle. The usual method of grubbing out these plants costs from $20 to $35 per acre. Treatments with 2,4-D at the rate of 1½ pounds per 100 gallons per acre gave an astonishingly high kill on plants from four to six feet tall. The complete removal of stored starch from the stems, and the small amount remaining in the root crown, together with the breaking down of the root crown, indicated that there would be no regrowth of most of the plants treated.

Tests on Water Hyacinth

Water hyacinth treated with 2,4-D compounds showed a kill of at least 95 per cent. About a month after treatment, however, it became evident that a small amount of regrowth was taking place. In a month to six weeks this primary regrowth gave rise to a secondary growth which again covered the area treated. A second application on the secondary growth was not as effective in killing the water hyacinth as the original treatment. The new plants were smaller, and bloomed profusely. One of the disadvantages connected with spraying is that the dead plants floated in a soggy mass on the surface and were slow to decompose and break apart.

The quantity of plants killed by the first application, indicates the desirability of additional research on concentration, stickers, and time of application. Many of the waterways and fine fishing waters of the State have become infested with this pest and studies of control measures must be continued.

Discussion

The spraying experiments indicate that the 2,4-D compounds may become useful in controlling alligator weed and certain other pests at a relatively low cost per acre of spray materials. Considerable details remain to be worked out. The basic fundamentals of how 2,4-D works and its method of movement within the plant, are not well understood at present. Such studies are now being made by plant physiologists. A study of spray adjuvants, such as spreaders and stickers, is necessary. Manufacturers are making new variations of the basic chemical, and it is possible that a variant may be found which will be more toxic or specific for alligator weed than those tested. This means it will be necessary for a comparative testing of a large number of compounds until the field has been satisfactorily explored.

These compounds are new, and they have received much favorable publicity, but as yet their toxicity to cultivated plants has not been determined. Before their use can be generally recommended, it will be necessary to find out how they affect field and garden crops and whether they will affect plants grown later in the fields that have been sprayed.

The relative cheapness and toxicity of the 2,4-D compounds may, as the results accumulate, make most of the caustic weed killers obsolete, or relegate their use to specific weeds under specific conditions.

IV. Summary

This bulletin is a report of progress on tests made to control the alligator weed and some other important weeds of Louisiana.

During the past twenty years, the alligator weed has become a pest in South Louisiana. If not brought under control, the indications are that it will continue to cause serious trouble.

The alligator weed grows in waterways and lakes, and has also become established in cultivated land.

The alligator weed is propagated vegetatively. A fragment of a root or of a stem which contains a node will produce a new plant.

Tests have been made with the chemical compound, 2,4-D, also known as hormone weed killer. This compound is taken up by the plant and is transported to the underground stems and roots.

In tests with 2,4-D, a high percentage of the alligator weed plants was killed and most of the plants were so weakened that they recovered slowly. While eradication has not been obtained, the results seem promising.

Many other weeds have also been killed by 2,4-D or at least weakened.

The results appear so promising that it is recommended that a weed project be set up at Louisiana State University, and that a study be made of all the important weeds of the State.

LOUISIANA BULLETIN NO. 403 JUNE, 1946

DIFFERENTIAL FERTILITY IN LOUISIANA

By

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DIFFERENTIAL FERTILITY IN LOUISIANA

by

J. ALLAN BEEGLE AND T. LYNN SMITH

I. SUMMARY

1. The rate of reproduction in Louisiana is still considerably above that necessary to replenish the population. Each year the surplus of births over deaths is sufficient to make for a considerable increase of population in the state, or to provide large numbers of migrants to other states.

2. The relative importance of the basic stocks in Louisiana's population is changing very rapidly. Some groups are failing by a wide margin to replace themselves, while others are contributing several members of the coming generation for every one living at present. This means that rapid changes are occurring in the relative importance of whites and Negroes, city people and farmers, French and Anglo-Saxons, Catholics and Protestants. In fact, there are wards in Louisiana wherein the rate of reproduction is four times higher than the rates prevailing in other sections of the state.

3. In proportion to population, Louisiana's farm people are producing more than two children for every one borne by the state's city people. This means that Louisiana farmers are producing an unduly large proportion of the succeeding generation, while its city folk fail by a wide margin to bear enough children to maintain numbers. There can be no doubt that the state's cities would decline were they not constantly replenished by a stream of migrants from the rural areas. Also, it is certain that farm people are bearing much more than their proportional share of the costs of rearing and educating Louisiana's future citizenry. The state faces no greater problems than those of seeing that opportunities for healthful living, education, and the costs of rearing the oncoming generation are more equitably distributed among all its people.

4. Contrary to popular belief, Negroes in Louisiana do not have a birth rate far above that of the white population. Farm Negroes are reproducing more rapidly than the whites who live on farms, but, on the other hand, urban Negroes are less prolific than urban whites.

5. The population of French-Catholic south Louisiana is multiplying far more rapidly than that of Anglo-Saxon, Protestant north Louisiana. This difference prevails among all residential groups of both races. Except for the rural-urban differential it is the most significant difference observed.

6. Careful comparisons of similar residential, racial and cultural

groups indicate that type of farming exerts no pronounced influence upon the rate of reproduction. However, because they are inhabited by groups of French ethnic stock and culture, the Central Louisiana Mixed Farming Area, the Sugar Bowl, and the Rice Area are characterized by high rates of reproduction. On the other hand, the fertility of the population is comparatively low in the Brown Loam, the Red River Delta Cotton, and the Sand Hills Cutover type-of-farming areas.

7. In common with the other Southern States, Louisiana is contributing a disproportionately large share of the nation's future population. In comparison with most of the other states the rates of reproduction of Louisiana farm and rural-nonfarm populations are very high; however, the birth rate of urban people in the state compares very closely with urban birth rates elsewhere in the nation.

8. For at least 60 years, Louisiana's rate of reproduction has been falling steadily. This downward trend is not confined to the state, however, and is general throughout the nation, and indeed throughout the Western world. As a matter of fact, the falling birth rate in Louisiana seems to have lagged somewhat in comparison with general declines in North America and Europe.

II. INTRODUCTION

Importance of the Rate of Reproduction

The rate of reproduction, the death rate, and migration are the three factors which determine human numbers, the distribution of the population, and the basic ethnic stocks of which mankind is composed. This study deals with the first and, in many ways, the most important of the three.

Variations in the rates at which two groups are reproducing will profoundly alter, in the course of a few generations, the composition and social characteristics of a nation or other group. For this reason, rates of reproduction are of tremendous significance in the determination of population trends and in foreseeing what the future population will be. Therefore, a knowledge of the fertility of the population is basic for all local, state, regional, and national planning.

Objectives

In this study of reproduction rates in Louisiana, five objectives were primary. We wanted to know: (1) how rapidly the population is reproducing; (2) how the rate of reproduction varies from one part of the state to another; (3) the nature and extent of the differences in fertility between the different groups composing the population, such as urban residents and farmers, whites and Negroes, French and Anglo-Saxons, Catholics and Protestants; (4) how the rates of reproduction in Louisiana compare with those of similar residential and racial groups in the nation and in the South; and (5) the trends in fertility of Louisiana people and how these compare with those in the United States, generally, and also with the changes that are taking place in other countries.

Data and Procedure

Except for a brief consideration of trends in fertility, this study is largely restricted to an analysis of reproduction rates in Louisiana in 1940. The basic data are from the volumes of the *Sixteenth Census of the United States.*[1]

The fertility ratio is the measure of the reproduction rate used throughout this study. This ratio expresses the relationship between the number of young children in a population and the number of women in the childbearing ages.[2] It is computed as follows:

$$\text{Fertility Ratio} = \frac{\text{Number of children under 5}}{\text{Number of females 15-44}} \times 1{,}000$$

Although not a perfect measure of the rate of reproduction, this ratio has the following merits or advantages: (1) it is partially refined or standardized by age and sex; (2) it does not rely upon birth registration data; (3) it is not so likely to lead the non-specialist astray as is the birth rate; and (4) it can be calculated easily from information ordinarily obtained in a community survey.

On the other hand, its most serious disadvantages arise from the facts that: (1) its validity is reduced if there is a high concentration of women in certain ages of the childbearing span; (2) it is available for large areas such as states and the United States for census years only; (3) it cannot readily be used as a measure of the fertility of the foreign-born; and (4) it will be in error if there is any tendency for small children to be enumerated in one category and their mothers in another.[3]

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[1] Sixteenth Census of the United States, *Population: Characteristics of the Population of Louisiana,* Second Series (Washington, D.C.: Government Printing Office, 1941).

[2] Students of population have commonly based the ratio either upon the number of women aged 20-44, or upon the number of women aged 15-49. Still other variations in this ratio are to be found in the literature on fertility. The reasoning used in basing the ratio upon the number of women 15-44 in this study is set forth by Kuczynski as follows: "There are no definite limits to the childbearing age. But in Western and Northern Europe births of a mother under 15 years or over 50 years practically never occur. As to the relative limits, statisticians agree that women over 15 years are to be considered as of childbearing age, but the upper limit is flexible. Some draw the limit at 45 years while others put it at 50 years. The actual facts are not conclusive since the number of births for women from 45 to 50 years, while small, is not negligible. Theoretically, it is certainly more correct to relate the births to the women 15-50 years. But since the women of 45-50 years do not much influence the total number of women to which the number of births is related, their inclusion can have an undue effect upon the general fertility rate." Robert F. Kuczynski, *The Balance of Births and Deaths* (New York: The Macmillan Company, 1928), I pp. 102-103.

[3] An example of this occurs in some rural areas where a significant proportion of young Negro children are living with their grandparents, their mothers residing and working in a city. See Louise Kemp, "A Note on the Use of the Fertility Ratio in the Study of Rural-Urban Differences in Fertility," *Rural Sociology,* X (1945), pp. 312-313.

On the whole, the fertility ratio is a much more accurate measure of the reproduction rate than is the crude birth rate, a measure which merely relates the number of births during a period of time to the total population. Although a simple, generally understood measure which may be computed annually, the birth rate lacks refinement and may be inaccurate because of incomplete birth registration.[4]

Still another measure of the rate at which populations reproduce is the net reproduction rate.[5] Although not computed as a part of this investigation, net reproduction rates are used in the succeeding section and in connection with the part dealing with trends in fertility.

The first step in this study consisted of calculating fertility ratios for the total population of each parish in Louisiana. These ratios were then classified and plotted on a map of the state. This was done in order to get a bird's-eye view of the variations in fertility from one section of the state to another. A study of these pointed to the necessity for additional refinement.

Hence, the second step involved the computation of fertility ratios for smaller, more homogeneous units, the wards. These ratios were then classified and plotted on a base map of the state as before. This procedure revealed a very close relationship between the presence of urban centers and low rates of reproduction.

Therefore, as a third step, it was believed essential to examine variations in fertility when the urban population was excluded from consideration. Hence, for each of 519 wards in Louisiana the population residing in incorporated centers was subtracted from the total population of the ward. Fertility ratios were then computed for the residual or "strictly rural" populations of the wards, and as before, the ratios classified and plotted on a base map of Louisiana.

To one who is familiar with the state, a careful study of these maps suggests the factors which are related to variations in fertility. First, the maps show that the wards and parishes containing the larger cities are the ones in which fertility is the lowest, while the more rural, isolated wards and parishes are the ones in which fertility is the highest. Thus, it appears that the rate of reproduction is inversely related to density of population, an association calling for investigation in detail.

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[4] For discussions of the birth rate, see Warren S. Thompson, *Population Problems* (3rd ed.; New York: McGraw-Hill Book Company, Inc., 1942), pp. 151-153, and T. Lynn Smith, *The Sociology of Rural Life* (New York: Harper and Brothers, 1940), pp. 131-132. For an analysis of the underenumeration of births, consult T. Lynn Smith, "Rural-Urban Differences in the Completeness of Birth Registration," *Social Forces*, XIV (1936), 368-372.

[5] See, for example, the methods of computing this rate in Kuczynski, *The Balance of Births and Deaths*, I, pp. 40-54. This net rate takes into consideration both birth and death data, expressing the net effect of the two variables. It shows how much a population may be expected to gain or lose every generation, assuming that the age distribution remains stabilized on the basis of existing birth and death rates for each age group. The rate of 1.0 or 100 is ordinarily taken as the level at which a population neither increases nor decreases. Rates above 1.0 or 100, therefore, indicate that a population is more than reproducing itself, and rates under 1.0 or 100 indicate that a population is failing to replace itself.

Second, the maps indicate that among the areas having large proportions of Negroes[6] some are characterized by high fertility while others have a low fertility. On the one hand, the Delta plantation areas, where Negroes are heavily concentrated, are low in fertility; on the other, the Feliciana plantation area, where Negroes are also heavily concentrated, is high. Thus, while the mapping procedures do not indicate in what way race and fertility are associated, they do indicate the necessity for careful study of the racial factor.

Third, the maps reveal a striking difference in fertility between the northern and southern portions of the state. Since north Louisiana is largely Anglo-Saxon and Protestant while south Louisiana is largely French and Catholic, it is suggested that high rates of reproduction are associated with the latter ethno-religious group. This factor, therefore, constitutes another relationship to be investigated in more detail.

Fourth, the maps indicate that rates of reproduction vary widely from one type-of-farming area to another. Throughout the Central Louisiana Mixed Farming, the Sugar Cane, and the Rice areas, fertility ratios are consistently high as compared with surrounding areas in which land use is different. Consequently, the factor of land use as related to the rate of reproduction constitutes another association which needs to be studied more thoroughly.

III. LOUISIANA'S POPULATION IS MORE THAN REPLACING ITSELF

Throughout most of the Western world the rates of reproduction have fallen so low that the members of the present generation are failing to produce enough children to take their places when they pass away. This appears to be true even in the United States. According to data gathered in the 1940 Census, the net reproduction rate for the United States as a whole was only 96, i.e., our reproduction rate lacked four per cent of being high enough to meet replacement needs. However, in Louisiana, and the South generally, the rate of reproduction is still sufficiently high to replace the present generation and to leave a surplus that can contribute to the growth of population in this and other regions.

This phase of our subject is best approached by an analysis of the net reproduction rates, measures which balance fertility against mortality and indicate the extent to which the population is replacing or failing to replace itself. The results for both races in all three residential areas in Louisiana and the United States are given in Table I.

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[6] Throughout this study non-whites are referred to as "Negroes" since "other races" represent a very small proportion of the total population. In Louisiana, races other than white or Negro represent less than .12 per cent of the total population since 1900. In the United States as a whole, in the North and South, and in the New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Central, and West South Central States, "other races" accounted for .5 per cent or less of the population in 1940. In the West and in the Mountain and Pacific States, the proportion of "other races" was less than 3.5 per cent.

TABLE I. NET REPRODUCTION RATES IN LOUISIANA AND THE UNITED STATES, BY RACE AND RESIDENCE, 1940*

Race and Residence	*Louisiana*	*United States*
All Classes	109	96
White	104	94
Non-White	119	107
Urban	77	74
White	76	74
Non-White	..	74
Rural-Nonfarm	118	114
White	..	114
Non-White	..	114
Rural-Farm	148	144
White	135	140
Non-White	163	160

*Source: *Sixteenth Census of the United States: 1940,* "Net Reproduction Rates by States (Preliminary)," Series P-5, No. 13, Washington: Government Printing Office.

Urban people in Louisiana are committing race suicide to about the same extent as city people in other parts of the nation. However, the net reproduction remains high in the country districts, and country people make up such a large proportion of the state's population that the balance of births and deaths in still favorable. The white population, however, cannot reduce its reproduction rate much more without entering the stage in which the population fails to reproduce itself.

IV. GREAT VARIATION IN THE RATES OF REPRODUCTION

The fertility of the population varies greatly from one part of Louisiana to another. In fact, the people in some portions of the state are reproducing at a rate more than four or five times that prevailing in other parts. It is the purpose of this section to furnish a bird's-eye view of the manner in which rates of reproduction vary throughout Louisiana.

Figure 1 shows at a glance that the rate of reproduction varies greatly from one parish to another. More careful inspection will show that the populations of those parishes containing large urban centers invariably are characterized by low fertility, while the populations of those which are most rural all have high reproduction rates. Thus, residents of parishes such as Orleans, Caddo, East Baton Rouge, Rapides, and Ouachita, each of which has a large urban center, are lowest in fertility. But, on the other hand, those of parishes such as Livingston, St. Helena, West Carroll, and West Feliciana, none of which contains centers large enough to qualify as urban, have the highest rates of reproduction.

The great variation in the rates at which the population of Louisiana is reproducing is emphasized even more clearly when the small, more homogeneous wards are used as a basis of comparison. (See Figure

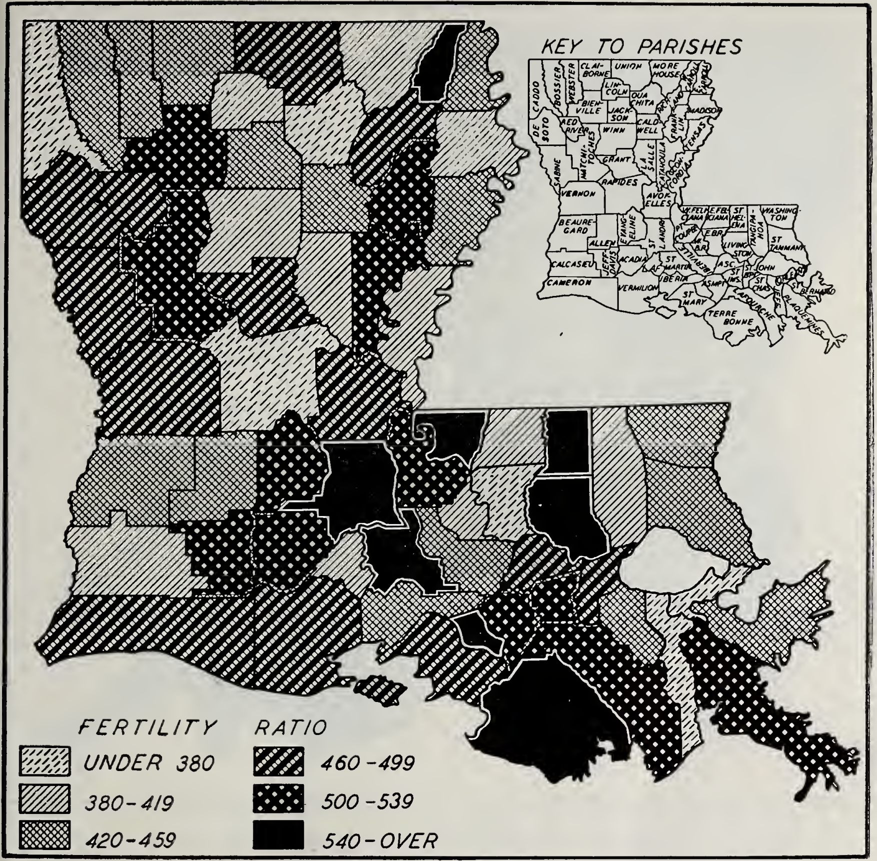

FIGURE 1. Variations in Fertility Ratios in Louisiana, by Parishes, 1940.

2.) All wards containing cities are the ones in which fertility is the very lowest. The wards in which New Orleans, Shreveport, Baton Rouge, Alexandria, and Monroe are located, all stand out because of the very low reproduction rates of their populations. Likewise, cities having more than 10,000 population—Bogalusa, Gretna, Lafayette, Lake Charles, and New Iberia—all greatly lower the rates of reproduction of the wards in which they are located. Even the wards containing the small towns and villages have relatively low rates of reproduction. On the other hand, the most isolated rural sections of Louisiana, the outlying wards in which there are no cities, towns, or villages, are those in which the fertility rates are the very highest.

These maps alone make it clear that urban residence results in low rates of reproduction; life on the farm, in the retention of the rapid rates of reproduction common in days gone by. They also suggest other factors that may be associated with variations in the birth rate. For ex-

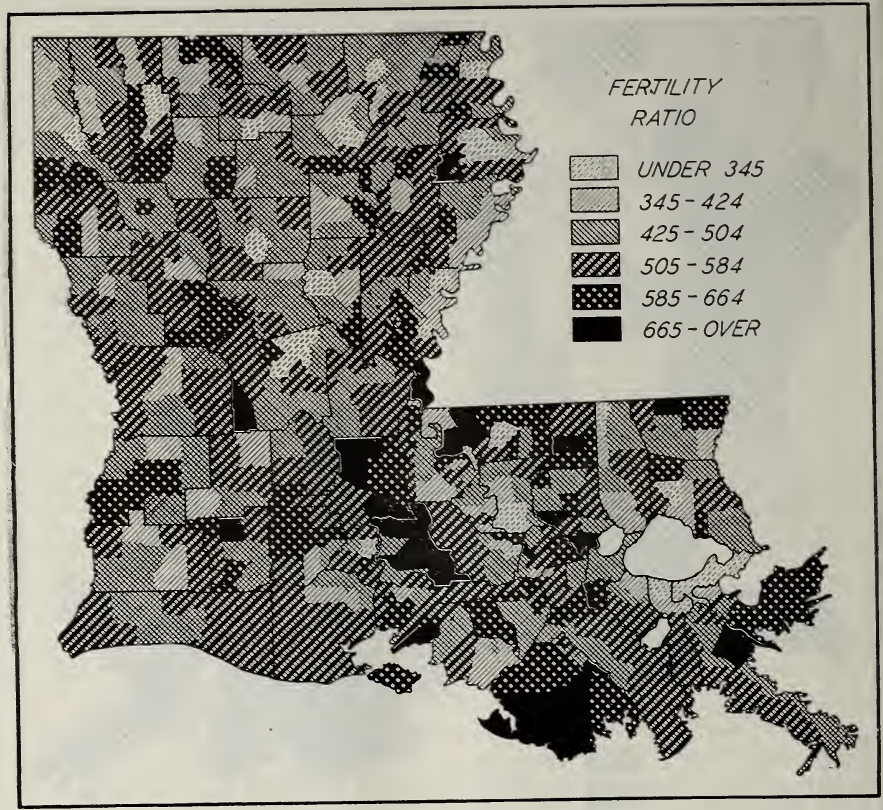

FIGURE 2. Variations in Fertility Ratios in Louisiana, by Wards, 1940.

ample, that rates of reproduction are higher in southern than in northern Louisiana seems evident from Figures 1 and 2, and this in turn suggests that Louisiana's population of French origin may be reproducing more rapidly than its people of Anglo-Saxon stock and culture.

Another variation of importance shown in Figure 2 is that fertility ratios throughout the Mississippi Delta, especially in the areas where Negroes are heavily concentrated, are consistently low. In the tiers of wards removed somewhat from the river where the proportion of Negroes is lower, fertility ratios are high. (See Figure 3.) Further comparisons of Figures 2 and 3 indicate that in some areas of the state high rates of reproduction are associated with high proportions of Negroes; in others, high rates are associated with small proportions of Negroes. The exact nature of this relationship, however, cannot be determined from these figures.

These maps also seem to indicate that the populations of wards comprising the Sugar Bowl and the Mixed Farming section of central Louisiana have higher rates of reproduction than the populations in

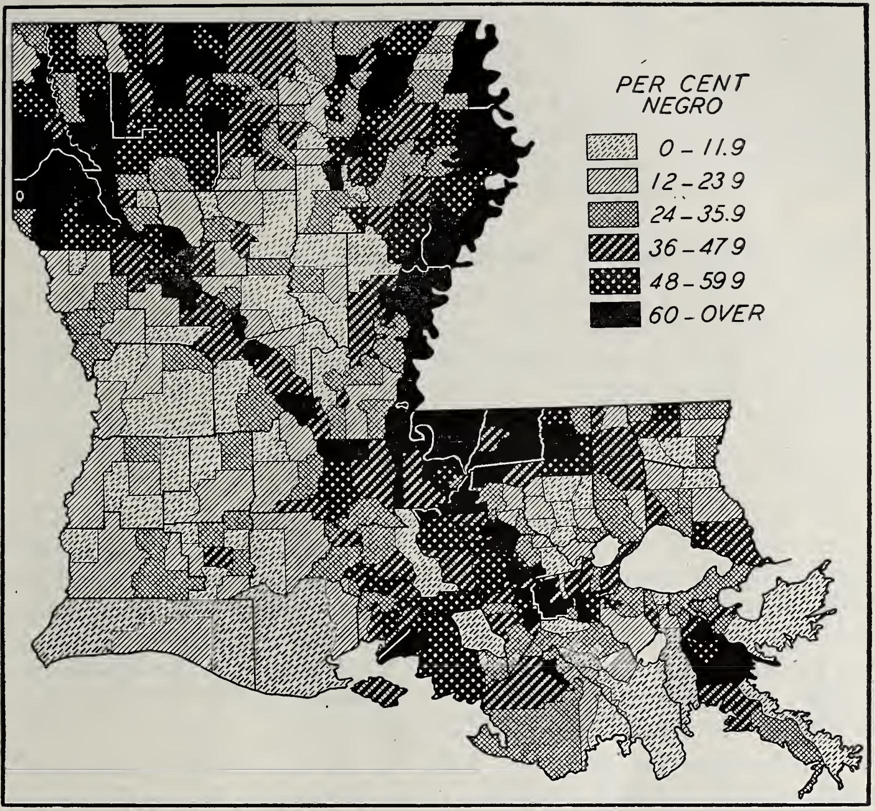

FIGURE 3. Distribution of the Negro Population in Louisiana, by Wards, 1940.

the farming areas surrounding them. The population of a fairly extensive area in north central Louisiana known as the Sand Hills appears to be distinctly less prolific than the residents of the areas having other types of farming.

Thus, these maps indicate that the various different groups in the population of the state are reproducing at widely different rates. The nature of the rural-urban differential is clear, and some other factors also appear to be associated with these variations. In the following sections, the precise relationships between residence, race, type of farming and the rate of reproduction are treated in detail.

V. WHAT GROUPS BEAR LOUISIANA'S CHILDREN?

Differences by Residence

No factor is more closely related to human fertility than that of residence. The high rural rates and the low urban rates were observed in the very earliest stages of this investigation. Here we analyze in more detail the exact nature of the relationship between residence and rate of reproduction. The analysis consists of determining: (1) differentials existing between the urban, rural-nonfarm, and rural-farm segments of the population; and (2) differentials existing between communities of various sizes and also between the populations of incorporated and unincorporated areas. The incorporated centers are grouped by size as follows: 1,000 to 2,500 population; 2,500 to 10,000 population; 10,000 to 100,000 population; and 100,000 population and over.

Urban, Rural-Nonfarm, and Rural-Farm Differences

For the state of Louisiana taken as a whole, rates of reproduction are lowest in the urban centers, higher in rural-nonfarm territory, and highest of all in the rural-farm areas. Fertility ratios for these three residential categories are 258, 430, and 546, respectively. (See Table II.) These data indicate that, in proportion to population, Louisiana's farming people are bearing more than two children for every one borne by the residents of urban centers.

The racial factor, the concentration of Negroes in the rural areas, is not responsible for these variations. The differentials are even greater among Negroes than among white people, and they are very great for both races. Thus, the rates of reproduction among Louisiana's white residents vary from a low of 256 for her urban population, to 434 for her rural-nonfarm residents, and to a high of 506 for her rural-farm people. Among Negroes the rates of reproduction for the three residential groups are 261, 421, and 595, respectively.

Furthermore, as shown in Table II, the low urban, intermediate rural-nonfarm, and high rural-farm ratios characterize the populations of both French and non-French areas.[7] This relationship prevails in each of the areas for both whites and Negroes. Thus, these differences in fertility are true residential differences and may not be attributed to racial or to ethno-religious factors.

In addition, comparisons showed that for both races in all type-of-farming areas,[8] rates of reproduction are lowest for the urban population, intermediate for the rural-nonfarm population, and highest for the rural-farm population. Thus, residential differences in fertility remain regardless of type of farming.

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[7] Since the necessary data according to color are not available on a minor civil division basis, French Louisiana was delimited according to parish boundaries. The French area was taken to include the following parishes: Acadia, Ascension, Assumption, Avoyelles, Calcasieu, Cameron, Evangeline, Iberia, Iberville, Jefferson, Jefferson Davis, Lafayette, Lafourche, Plaquemines, Pointe Coupee, St. Bernard, St. Charles, St. James, St. John the Baptist, St. Landry, St. Martin, St. Mary, Terrebonne, Vermilion, and West Baton Rouge. Orleans parish, co-extensive with the city of New Orleans, was excluded from consideration since it would unduly weight either of the categories.

[8] A simplified classification of type of farming in the state must be used because of the necessity of separating the data by race. The classification used here is as fol-

TABLE II. Fertility Ratios for Ethno-Religious and Type-of-Farming Areas in Louisiana, by Residence and Race, 1940

Area and Race	*Fertility Ratios by Residence*			
	Total	*Urban*	*Rural-Nonfarm*	*Rural-Farm*
Louisiana				
Both	386	258	430	546
White	367	256	434	506
Negro	418	261	421	595
French Louisiana				
Both	479	344	474	574
White	445	340	459	511
Negro	554	356	518	682
Non-French Louisiana				
Both	400	244	392	530
White	391	259	411	502
Negro	411	221	354	558
Upland Cotton				
Both	427	262	406	553
White	400	276	424	482
Negro	467	240	368	637
Delta Cotton				
Both	398	237	377	539
White	392	252	393	538
Negro	406	216	344	540
Rice				
Both	456	342	502	549
White	447	334	497	517
Negro	487	363	522	748
Cane				
Both	495	358	505	568
White	472	361	498	526
Negro	536	352	520	618
Small Fruits and Vegetables				
Both	416	320	418	486
White	398	320	394	464
Negro	466	317	493	544

lows: *Upland Cotton*—Beauregard, Bienville, Caldwell, Cameron, Claiborne, De Soto, East Baton Rouge, East Feliciana, Evangeline, Grant, Jackson, Lafayette, La Salle, Lincoln, Morehouse, Ouachita, Sabine, St. Helena, St. Landry, Union, Vernon, Washington, Webster, West Feliciana, and Winn; *Delta Cotton*—Avoyelles, Bossier, Caddo, Catahoula, Concordia, East Carroll, Franklin, Madison, Natchitoches, Pointe Coupee, Rapides, Red River, Richland, Tensas, and West Carroll; *Rice*—Acadia, Allen, Calcasieu, Jefferson Davis, and Vermilion; *Cane*—Ascension, Assumption, Iberia, Iberville, Lafourche, St. James, St. John the Baptist, St. Martin, St. Mary, Terrebonne, and West Baton Rouge; *Small Fruits and Vegetables*—Jefferson, Livingston, Plaquemines, St. Bernard, St. Charles, St. Tammany, and Tangipahoa. T. Lynn Smith, *The Growth of Population in Louisiana 1890 to 1930* (Baton Rouge: Louisiana Agricultural Experiment Station Bulletin 264, 1935), pp. 4-5.

TABLE III. FERTILITY RATIOS OF THE PARISHES IN LOUISIANA, BY RESIDENCE AND RACE, 1940

Parish	Fertility Ratios by Residence and Race											
	Total			*Urban*			*Rural-Nonfarm*			*Rural-Farm*		
	Total	*White*	*Negro*	*Total*	*White*	*Negro*	*Total*	*White*	*Negro*	*Total*	*White*	*Negro*
Acadia	503	490	564	360	343	405	515	510	567	606	575	807
Allen	452	469	407	333	356	281	487	526	417	497	484	571
Ascension	481	462	513	296	276	338	516	524	505	541	510	594
Assumption	528	474	608	...	...	...	480	452	525	573	496	680
Avoyelles	498	465	591	320	332	289	465	461	478	548	492	705
Beauregard	457	479	362	312	314	310	522	557	402	520	521	500
Bienville	502	431	576	...	...	...	314	287	350	595	515	668
Bossier	432	369	491	314	312	319	378	386	357	513	413	546
Caddo	282	268	299	219	232	199	371	370	373	490	393	517
Calcasieu	401	400	403	311	308	317	499	489	538	526	493	671
Caldwell	438	430	459	...	...	...	385	385	386	487	470	527
Cameron	492	477	672	...	...	...	483	488	333	500	468	748
Catahoula	516	547	466	...	...	...	353	420	236	588	604	561
Claiborne	450	345	529	233	255	210	303	298	315	548	411	613
Concordia	399	476	365	220	288	187	415	490	369	472	570	437
De Soto	484	501	528	300	324	272	429	444	412	541	421	584
East Baton Rouge	292	297	284	204	207	200	339	367	295	458	383	527
East Carroll	430	581	368	241	381	169	334	505	257	502	673	438
East Feliciana	403	199	511	73	91	44	312	264	354	619	393	661
Evangeline	528	458	785	406	372	605	495	462	675	564	479	830
Franklin	511	545	463	244	273	206	310	321	288	571	609	517
Grant	467	478	436	...	...	...	465	495	360	469	450	598
Iberia	447	432	474	348	355	334	520	510	539	568	525	628
Iberville	438	418	457	296	313	263	446	447	444	509	476	530
Jackson	428	411	464	253	286	149	425	446	385	515	440	651
Jefferson	341	340	345	328	337	295	349	345	373	287	268	500
Jefferson Davis	501	464	620	409	383	482	483	442	607	600	549	812
Lafayette	409	361	518	293	284	317	424	377	607	555	466	714
Lafourche	510	500	569	377	376	377	521	515	598	558	535	647
La Salle	416	426	359	...	...	...	423	445	322	401	388	571
Lincoln	405	376	437	258	252	264	418	431	396	495	448	538
Livingston	553	545	596	...	...	...	557	538	658	551	549	558

Fertility Ratios by Residence and Race

Parish	*Total*			*Urban*			*Rural-Nonfarm*			*Rural-Farm*		
	Total	*White*	*Negro*	*Total*	*White*	*Negro*	*Total*	*White*	*Negro*	*Total*	*White*	*Negro*
Madison	404	475	375	236	314	202	393	551	278	520	586	496
Morehouse	401	415	392	240	301	164	313	370	222	506	568	485
Natchitoches	504	466	544	280	275	285	455	460	444	596	540	644
Orleans	239	225	269	239	225	269	...	...	...	...	...	...
Ouachita	304	323	276	235	256	204	421	440	351	485	472	500
Plaquemines	535	436	676	...	...	...	531	460	658	542	372	702
Pointe Coupee	500	441	545	...	...	...	401	394	411	534	467	574
Rapides	359	348	378	266	272	256	371	380	347	537	471	618
Red River	490	449	530	...	...	...	356	363	338	529	493	556
Richland	481	503	456	...	...	...	290	336	238	542	557	526
Sabine	482	496	431	...	...	...	463	506	361	501	489	572
St. Bernard	440	422	520	...	...	...	449	434	513	360	325	619
St. Charles	444	402	549	...	...	...	443	406	544	447	381	570
St. Helena	602	471	721	...	...	...	493	421	689	619	485	723
St. James	520	465	580	...	...	...	506	463	555	544	469	620
St. John the Baptist	499	436	576	...	...	...	484	435	554	554	444	633
St. Landry	584	503	682	377	368	393	512	497	537	691	577	797
St. Martin	581	535	667	402	397	410	517	535	430	660	575	775
St. Mary	468	431	514	381	372	401	485	477	497	570	518	594
St. Tammany	437	406	503	312	288	360	513	471	579	476	454	593
Tangipahoa	405	401	415	311	311	311	354	350	363	471	459	496
Tensas	445	524	413	...	...	...	278	330	244	503	634	461
Terrebonne	548	525	613	384	388	361	607	593	651	622	590	672
Union	466	420	550	...	...	...	312	289	349	522	465	628
Vermilion	460	443	570	367	347	450	521	518	536	482	455	742
Vernon	477	497	363	281	291	257	555	606	360	495	489	625
Washington	449	443	462	356	386	300	414	417	409	569	515	689
Webster	425	395	464	281	311	236	422	425	413	541	455	604
West Baton Rouge	414	382	435	...	...	...	372	368	378	447	409	458
West Carroll	547	575	456	...	...	...	359	408	246	601	619	539
West Feliciana	573	348	639	...	...	...	435	335	502	630	362	679
Winn	406	424	363	232	259	196	513	541	438	476	449	592

It should be indicated, however, that residential differences, although great and of first importance, are by no means the only ones present. Within each of the three residential groups there are wide variations from one parish to another. The people of some of the parishes, in any of the three residential categories, are twice as fertile as those of corresponding residence in other parishes. (See Table III.) Nevertheless, the high rates of reproduction among the rural-farm people, the intermediate position of the rural-nonfarm population, and the very low fertility ratios in towns and cities are evident throughout the state. See Figures 4, 5, 6, and 7, which indicate that rural-farm residents, regardless of race, are generally more fertile than the rural-nonfarm residents.

Variations within Unincorporated Territory

From many points of view the best way to separate the rural population from the urban is to classify all persons living in unincorporated territory as rural. In any case, an analysis of the variations in the fertility of the population living outside incorporated centers contributes to a knowledge of the variations that are to be found within the rural population. (See Figure 8.) From this map a number of pertinent observations may be made, most of them merely supporting findings given above but some of them casting additional light on the question.

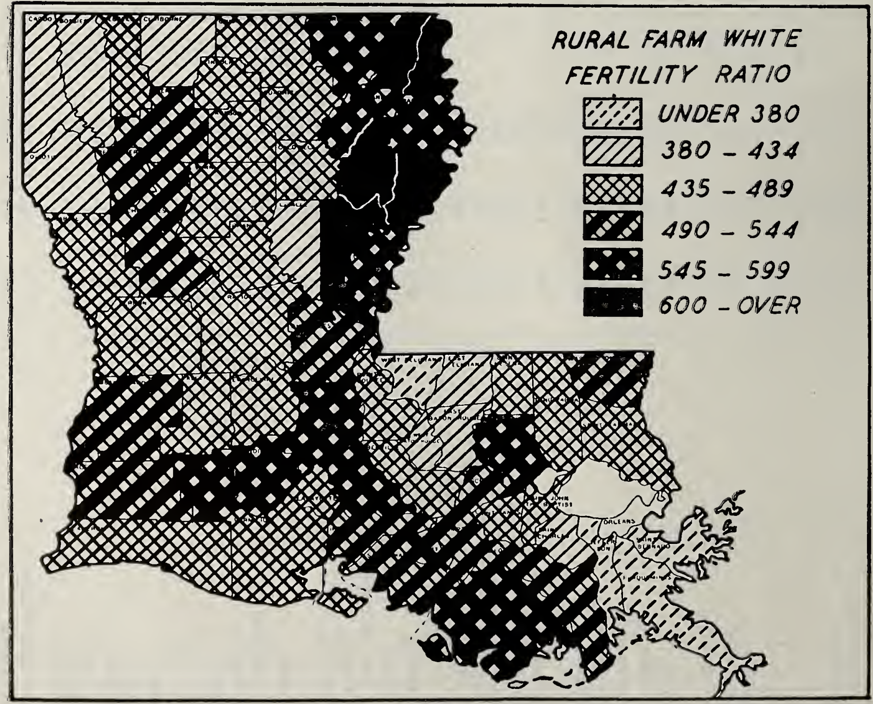

FIGURE 4. Fertility Ratios of Rural-Farm Whites in Louisiana, by Parishes, 1940.

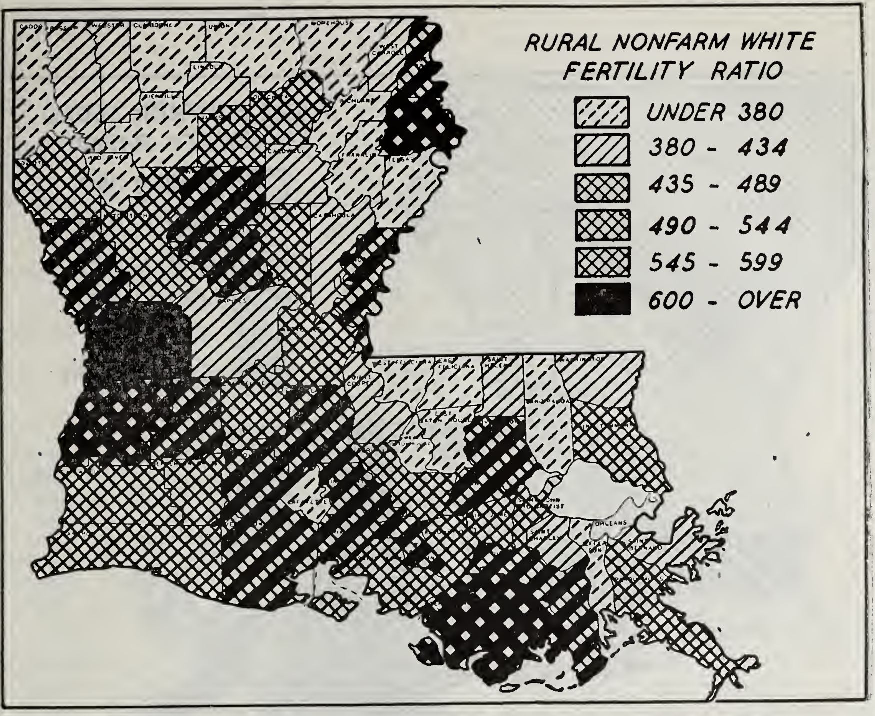

FIGURE 5. Fertility Ratios of Rural-Nonfarm Whites in Louisiana, by Parishes, 1940.

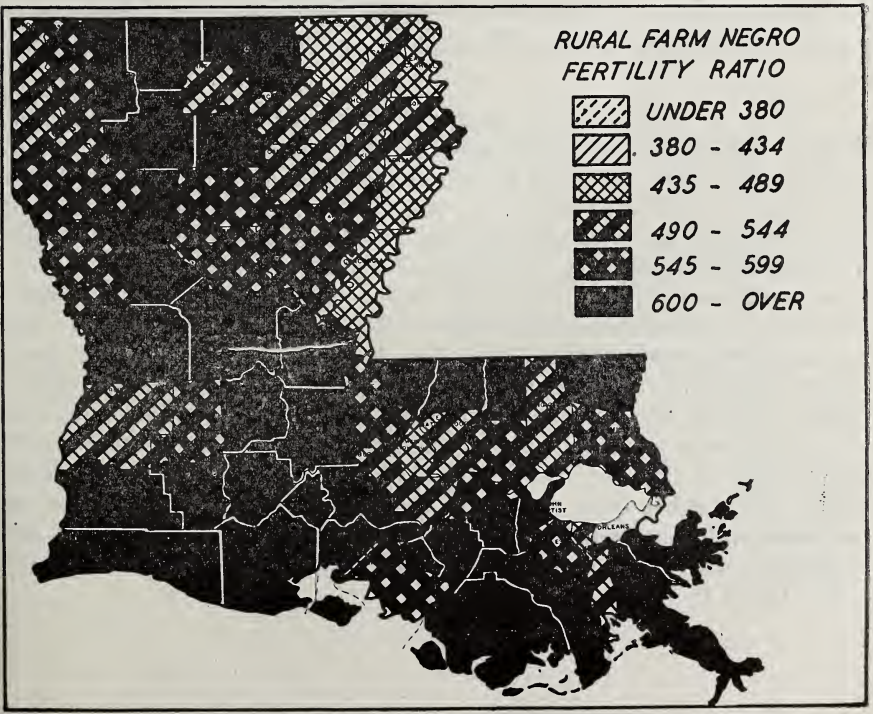

FIGURE 6. Fertility Ratios of Rural-Farm Negroes in Louisiana, by Parishes, 1940.

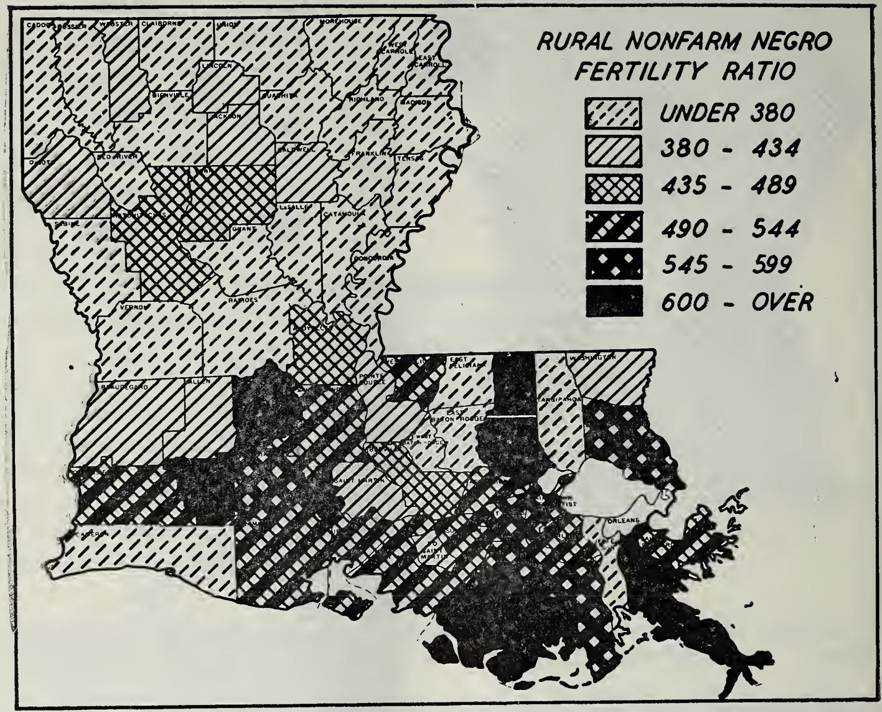

FIGURE 7. Fertility Ratios of Rural-Nonfarm Negroes in Louisiana, by Parishes, 1940.

Rates of reproduction among the rural population are noticeably high in southern or French Louisiana, and particularly in the swampy and marshy areas inhabited by fishermen, trappers, and hunters. Above the mouth of the Red River the people living in the wards adjoining the Mississippi River have fairly low rates of reproduction, while those residing farther back, in the floodwater and spillway sections, are reproducing very rapidly. Not only do the towns and cities have reproduction rates much lower than that of the population in the open country areas surrounding them, but all such urban centers seem to exert a depressing effect in the areas adjacent to them. In fact, it seems fair to make the generalization that the fertility of the rural population declines as proximity to an urban center increases. Or, to put it in other words, the closer to a city, the lower the rate of reproduction of the rural population; the farther from a city, the higher the rate of reproduction. All unincorporated areas taken together had in 1940 a fertility ratio of 510, compared with one of only 265 for all incorporated areas collectively. (See Table IV.)

TABLE IV. Fertility Ratios in Ethno-Religious and Type-of-Farming Areas in Louisiana, by Size of Community and Race, 1940

Area and Race	*Fertility Ratios by Residence*					
	Unincorporated Territory	*Incorporated Centers*	*1,000–2,500*	*2,500–10,000*	*10,000–100,000*	*100,000 or more*
Louisiana						
Both	510	265	343	317	247	239
White	...	...	...	330	256	225
Negro	...	...	...	290	232	269
French Louisiana						
Both	538	353	389	371	303	...
White	...	...	...	365	297	...
Negro	...	...	...	387	318	...
Non-French Louisiana						
Both	491	251	306	269	230	...
White	...	...	...	292	243	...
Negro	...	...	...	237	212	...
Upland Cotton						
Both	507	268	336	276	246	...
White	...	...	...	295	256	...
Negro	...	...	...	244	230	...
Delta Cotton						
Both	501	247	320	275	227	...
White	...	...	...	308	238	...
Negro	...	...	...	237	210	...
Cane						
Both	546	361	376	366	338	...
White	...	...	...	363	353	...
Negro	...	...	...	371	307	...
Rice						
Both	552	355	399	372	294	...
White	...	...	...	361	273	...
Negro	...	...	...	407	325	...
Small Fruits and Vegetables						
Both	456	318	313	331	296	...
White	...	...	...	337	291	...
Negro	...	...	...	319	313	...

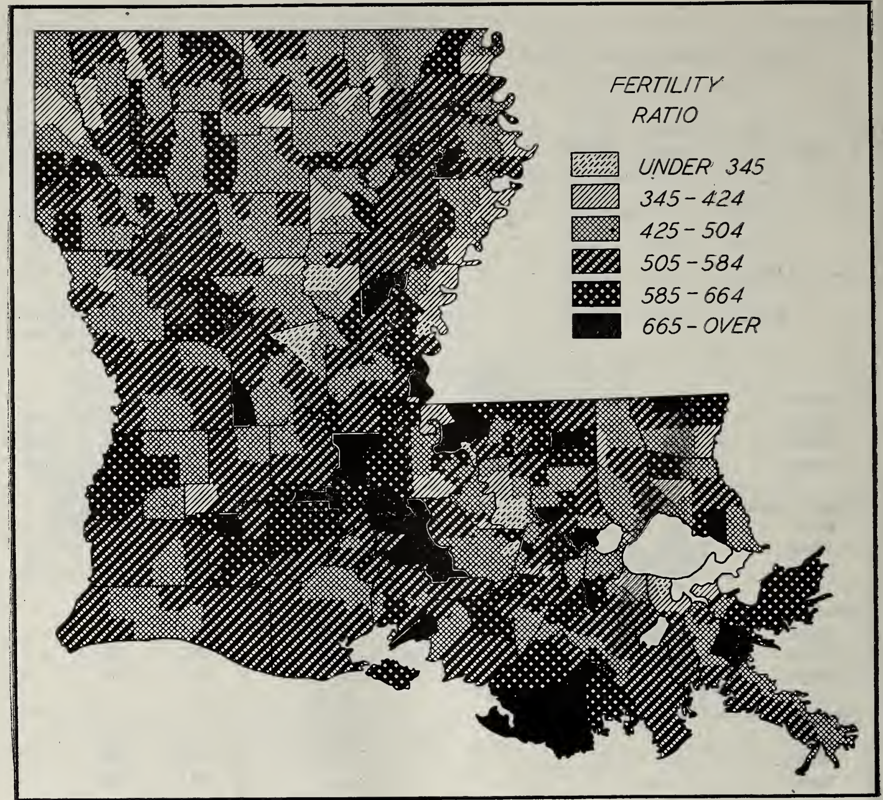

FIGURE 8. Fertility Ratios of the Population of Unincorporated Areas of Louisiana, by Wards, 1940.

Variations by Size of Incorporated Center

Within the urban population the rate of reproduction varies inversely with the size of the center. (See Figure 9.) In constructing this map, circles proportionate to the sizes of the populations indicate the location of each town or city and the shading indicates the magnitude of the fertility ratios. The residents of New Orleans, Shreveport, Baton Rouge, and Alexandria all have low rates of reproduction. Smaller cities also have low rates, but not so low as these four. The smallest aggregates, on the other hand, are ordinarily the ones highest in fertility. Even though the residents of villages and towns in the southern portion of the state are characterized by higher rates of reproduction than those in the northern part of the state, in each area taken separately it appears that the rate of reproduction decreases as the size of urban aggregate increases.

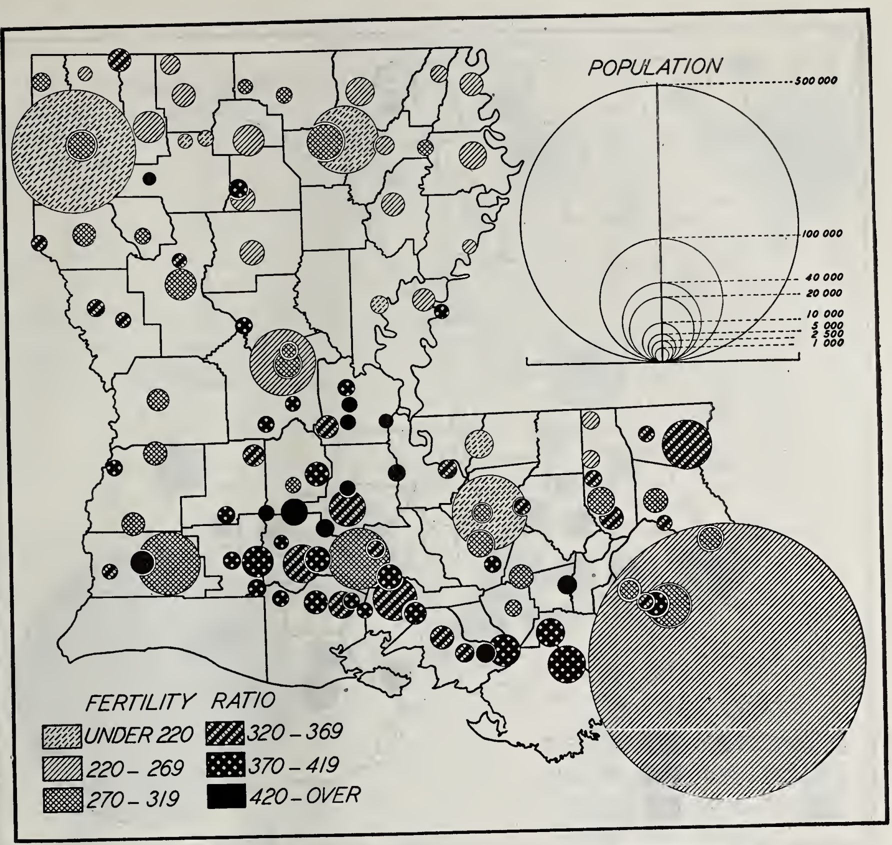

FIGURE 9. Fertility Ratios in Incorporated Centers of 1,000 Population or More in Louisiana, by Size, 1940.

The tendency for the rate of reproduction to fall as the size of the urban center increases seems to be true for both the white and the Negro populations. (See Figure 10. As in Figure 9, the area of the circle indicates the size of the population, the shading the fertility ratios. But the manner of indicating the racial division of the population calls for explanation. The segment representing the proportion of Negroes is marked by a heavy line starting at nine o'clock and extending clockwise.) The principal exception to this is the instance of New Orleans Negroes, who have a higher fertility rate than Negroes in cities with populations between 10,000 and 100,000. However, the principle holds true in both French and non-French Louisiana, and for all type-of-farming areas. In the Small Fruits and Vegetables Area, however, the fertility rate for population centers having from 1,000 to 2,500 population is lower than that for aggregates having 2,500 to 10,000 population.

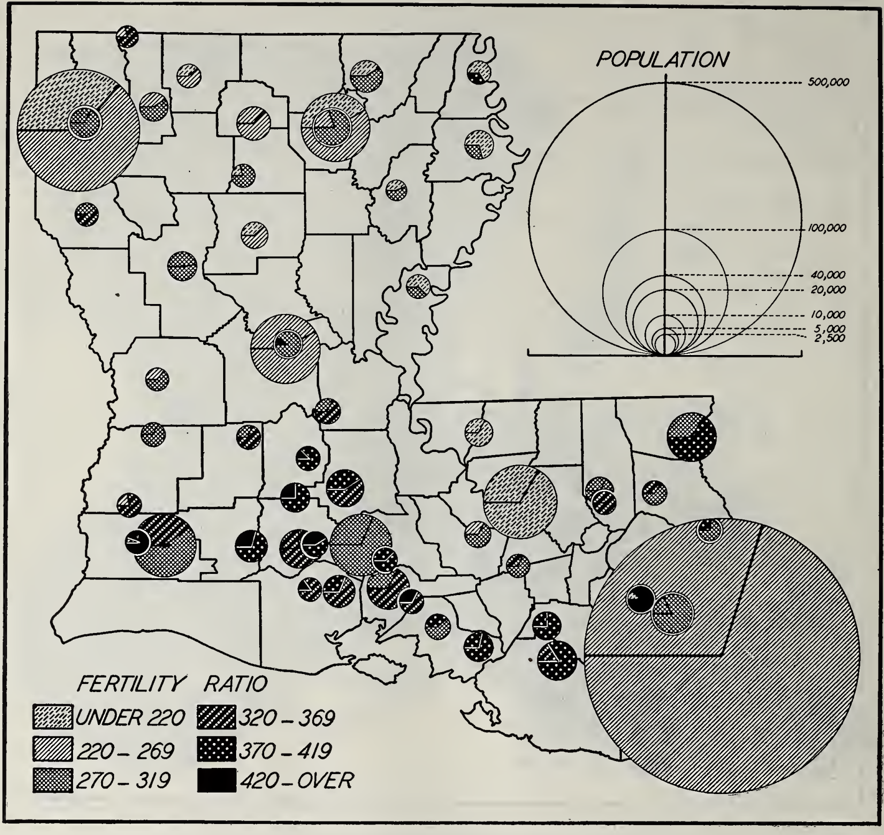

FIGURE 10. Fertility Ratios in Incorporated Centers of 2,500 Population or More in Louisiana, by Size of Center and Race, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line.)

Summary

The chief residential differentials in fertility may be summarized as follows:

1. Rural-farm people in Louisiana have by far the highest rates of reproduction in the entire state; the rural-nonfarm population has intermediate rates; and urban residents are characterized by the lowest rates of all. This relationship prevails among both whites and Negroes, in both French and Anglo-Saxon Louisiana, and in each of the five type-of-farming areas.

2. Persons residing in the unincorporated portions of Louisiana have much higher rates of reproduction than those living in the incorporated centers. Within the incorporated centers, fertility ratios decline as the size of center increases. This relationship is characteristic of both racial groups, in French and Anglo-Saxon Louisiana, and in all type-of-farming areas.

Racial Differences

Contrary to popular supposition, Louisiana's Negroes are not reproducing themselves at a rate far above that of the white population. That they do enjoy a slight superiority in this respect is largely due to the fact that they still live amid rural surroundings (where the birth rate remains high) in higher proportions than their white fellows.

In urban areas of the state the rates of reproduction of whites and Negroes are both about equally low, the fertility ratios being 256 and 261, respectively. Among the urban populations of the 41 parishes containing urban centers, in only 16 do Negroes have higher rates of reproduction than whites. (See Table III.) Furthermore, a study of Table IV and Figure 10 will indicate that the white population has a higher rate of reproduction than the Negro in most of the state's larger towns and cities. Thus, in 44 small urban centers (less than 10,000 inhabitants) the fertility of whites is higher than that of Negroes in 23; and in six of ten cities with more than 10,000 inhabitants, whites are reproducing them-

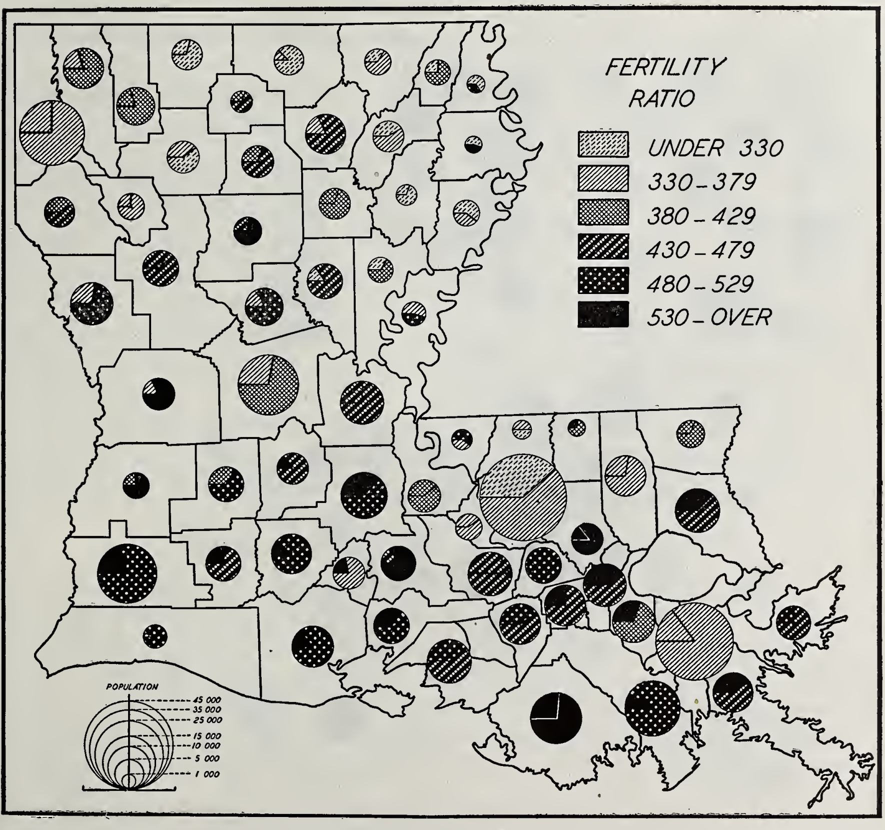

FIGURE 11. Fertility Ratios of Rural-Nonfarm Residents in Louisiana, by Race and Parish, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line.)

selves more rapidly than the Negroes. It is also interesting to note that the urban centers in which the fertility of Negroes exceeds that of the white populations are all located in south Louisiana, in the French section of the state. New Orleans, which weighs so heavily in the state totals, is the outstanding example of this, having a fertility ratio among Negroes (269) that is substantially above that for whites (225).

Among the rural-nonfarm population of the state the white population seems to be reproducing somewhat more rapidly than the Negro, the fertility ratios being 434 for the former and 421 for the latter. (See Table III and Figure 11.) However, little significance should be attached to this difference for the state, since in 32 of the 63 parishes containing rural-nonfarm populations the fertility ratios of Negroes are above those of the white people. As in the case of the urban population, in Protestant, Anglo-Saxon north Louisiana the differential is favorable to the whites, while in Catholic, French south Louisiana the differential is in favor of the Negroes.

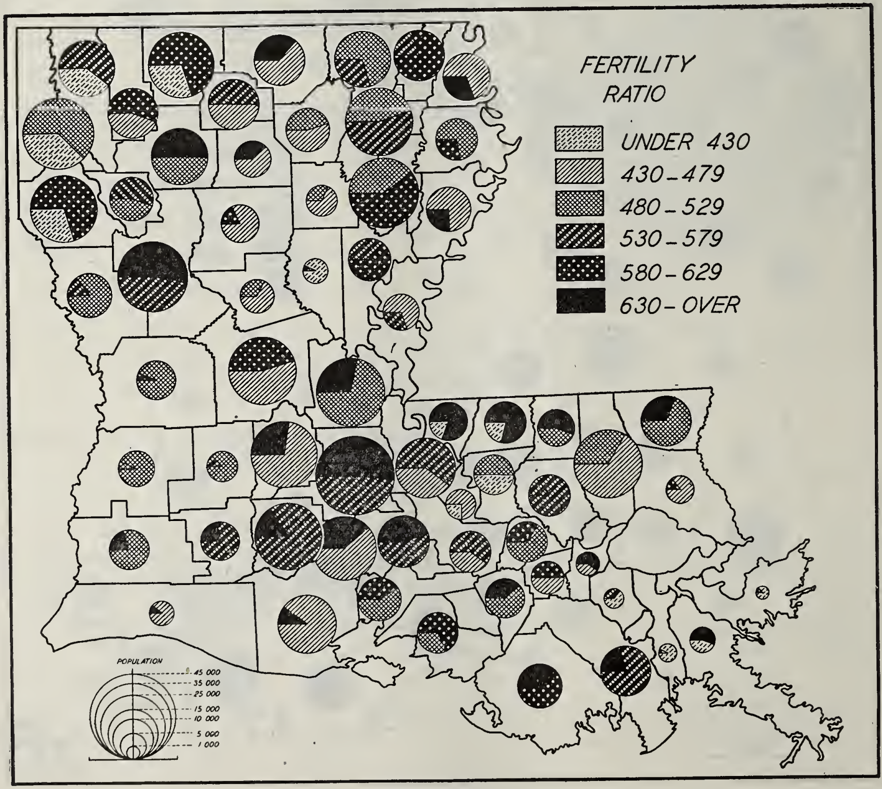

FIGURE 12. Fertility Ratios of Rural-Farm Residents in Louisiana, by Race and Parish, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line.)

Possibly for the reason that they live amid even more rural surroundings than the whites, rural-farm Negroes are reproducing considerably faster than the white people who live on farms. The fertility ratios are 596 for rural-farm Negroes and 506 for rural-farm whites. (See Table III and Figure 12.) Only in a few Mississippi Delta parishes (Concordia, Tensas, Madison, East Carroll, Morehouse, Richland, Franklin, and Catahoula) and in Beauregard is the differential favorable to the white population.

It is not possible to determine fertility ratios separately for whites and Negroes in the smallest subdivisions, the wards, of the state, which would carry the analysis to its logical conclusion. However, it is possible to probe a bit deeper (see Table V), and to demonstrate that there is no consistent tendency for the fertility of the population to increase as the percentage of Negroes in the population rises. Even among the population living outside incorporated centers, there is no consistent relationship between these two variables.

In summary, the following generalizations may be made concerning racial differentials in reproduction rates in Louisiana.

1. In the state as a whole Negroes seem to be multiplying slightly more rapidly than the white population, but this appears to be due to the fact that a higher proportion of the colored population resides amid rural surroundings. To the extent that we have been able to correct for these environmental differences and compare similar residential areas, the racial differences have tended to disappear.

2. In the cities the white population seems to be reproducing more rapidly than the Negro, while on the farms the opposite is true.[9] In rural-nonfarm areas, the advantage also appears to be slightly in favor of the white population. However, in the Delta cotton, plantation sections along the Mississippi River, where such a large share of the state's Negroes are concentrated, the white people who live on farms are reproducing much more rapidly than the Negro.

3. On the whole, the white population of Anglo-Saxon, Protestant north Louisiana is multiplying more rapidly than the Negro, while in French, Catholic south Louisiana the advantage lies with the colored race.

Differences by Ethno-Religious Areas

The residents of the French, Catholic portion of Louisiana are characterized by much higher rates of reproduction than those of the Anglo-Saxon, Protestant portion. This is true for both racial groups in all of the residential classifications. The difference in the rate of reproduction between southern and northern Louisiana is so great that it appears first when dealing with the large, heterogeneous parishes (Figure 1), and it is emphasized by every refinement introduced in the course of the analysis.

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[9] The effect upon the fertility ratio of Negro children being left on the farm with their grandparents while their mothers are living in the city probably accounts for much of this variation.

TABLE V. FERTILITY RATIOS WITHIN THE TYPE-OF-FARMING AREAS IN LOUISIANA, CLASSIFIED ACCORDING TO THE PROPORTION OF NEGROES AND THE DEGREE OF URBANITY, 1940

Type-of-Farming Area	*Fertility Ratios by Degree of Urbanity and Percentage of Negroes*									
	Total					*10.000 or More*				
	Total	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent and Over*	*Total*	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent and Over*
TOTAL	430	492	450	396	483	268	...	345	261	...
Upland Cotton	452	407	425	440	509	...	...	...	...	...
Delta-Red River Cotton	371	555	457	330	450	239	...	...	239	...
Sand Hills-Cutover	440	489	420	397	...	...	...	...	...	...
Central Louisiana Mixed	507	492	515	498	558	329	...	...	329	...
Rice	472	509	483	423	...	358	...	...	358	...
Sugar Cane	493	519	525	467	533	360	...	...	360	...
Brown Loam Mixed	322	609	331	271	423	204	...	...	204	...
East Louisiana Cotton-Dairy-Part Time	467	484	420	484	613	364	...	364	...	...
Strawberry	433	578	462	377	...	...	...	...	...	...
Gulf Coast Dairy-Trucking-Fruit	398	360	367	443	601	315	...	308	332	...

TABLE V (Continued)

Type-of-Farming Area	*Fertility Ratios by Degree of Urbanity and Percentage of Negroes*														
	2,500 to 10,000					*Under 2,500*					*Unincorporated*				
	Total	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*	*Total*	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*	*Total*	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*
TOTAL	391	446	384	397	329	486	464	498	487	481	509	516	496	508	514
Upland Cotton	360	...	383	340	386	447	393	491	440	500	530	491	490	528	544
Delta-Red River Cotton	339	...	352	351	311	480	563	505	486	449	520	553	556	521	510
Sand Hills-Cutover	336	...	283	362	...	448	429	467	452	...	507	532	458	519	...
Central Louisiana Mixed	505	...	...	505	...	560	...	509	587	494	566	492	557	587	587
Rice	451	458	409	569	...	532	536	535	503	...	557	534	577	...	...
Sugar Cane	416	431	423	407	...	508	516	555	484	583	540	563	589	522	530
Brown Loam Mixed	130	...	...	130	...	460	...	...	332	484	401	609	331	403	404
East Louisiana Cotton-Dairy-Part Time	317	...	...	317	...	485	...	508	438	606	565	484	551	596	624
Strawberry	382	...	...	382	...	419	...	449	367	...	567	578	535	...	...
Gulf Coast Dairy-Trucking-Fruit	410	...	404	430	...	392	...	306	458	...	417	360	392	469	601

Consider some of the data. The urban population of the French section of Louisiana has a fertility ratio of 344 as compared with only 244 for the urban population of non-French Louisiana. Similarly, rural-nonfarm residents of the French portion are characterized by distinctly higher reproduction rates than those in the non-French portion, the former having a fertility ratio of 474 as compared with only 392 for the latter. Even the farm population of southern Louisiana is distinctly more fertile than the farm population of northern Louisiana, the fertility ratios being 574 and 530, respectively. (See Table VI.)

TABLE VI. FERTILITY RATIOS FOR ETHNO-RELIGIOUS AREAS IN LOUISIANA, BY RESIDENCE AND RACE, 1940

Residence Groups	*Fertility Ratios by Ethno-Religious Area and Race*					
	French Louisiana			*Non-French Louisiana*		
	Both	*White*	*Negro*	*Both*	*White*	*Negro*
Total	479	445	554	400	391	411
Urban	344	340	356	244	259	221
Rural-Nonfarm	474	459	518	392	411	354
Rural-Farm	574	511	682	530	502	558
Cities 10,000 to 100,000	303	297	318	230	243	212
Cities 2,500 to 10,000	371	365	387	269	292	237
Towns and Villages 1,000 to 2,500	389	...	...	306	...	...
All Incorporated Territory	353	...	...	251	...	...
All Unincorporated Territory	538	...	...	491	...	...

The ethno-religious difference in fertility holds true even after the population of the two areas is classified according to degree of urbanity. Residents of the urban centers in the French portion having between 10,000 and 100,000 population and 2,500 to 10,000 population are characterized by much higher rates of reproduction than those in the non-French portions. Thus, in cities of 10,000 to 100,000 population, the ratio is 303 as compared with 230; in cities of 2,500 to 10,000 population, the differential is even greater, 371 as compared with 269. The inhabitants of towns and villages having between 1,000 and 2,500 population in southern Louisiana are characterized by much higher fertility than those in northern Louisiana, the ratio being 389 as compared with 306.

These differentials remain after the data are further subdivided according to race. Thus, white and Negro urban residents of the French section have higher rates of reproduction than those living in the non-French section. Urban whites in the southern parishes have a fertility ratio of 340 as compared with 259 for those in the northern parishes; urban Negroes in the southern part of the state have an index of 356 as compared with only 221 for those living in the northern part. The higher rates of reproduction characterizing both races in French Louisiana hold true even after urban aggregates are classified by size.

White and Negro rural-nonfarm and rural-farm residents in the southern portion of the state also possess higher fertility rates than comparable groups in the northern portion. The rates for whites living in rural-nonfarm and rural-farm portions of the French area, however, are not greatly in excess of the indexes for the non-French area. Rural-nonfarm Negroes in the south have a fertility index of 518 as compared with only 354 for rural-nonfarm Negroes in the north. The rural-farm Negroes in the French section have a fertility index of 682, greatly in excess of 558, the fertility ratio for rural-farm Negroes in the non-French section. Thus, among both whites and Negroes of all residential categories, the people of French, Catholic south Louisiana are reproducing much more rapidly than those of Anglo-Saxon, Protestant north Louisiana.

Differences by Type-of-Farming Areas

To what extent are there differentials between the various type-of-farming areas in the rates of reproduction other than those due to differences in the racial, residential, and ethno-religious makeup of the population? The answer to this question is clear. While wide differences exist in the rates of reproduction between the type-of-farming areas in Louisiana, none is consistently highest for all residential and racial groups. The boundaries of the major type-of-farming areas in the state,

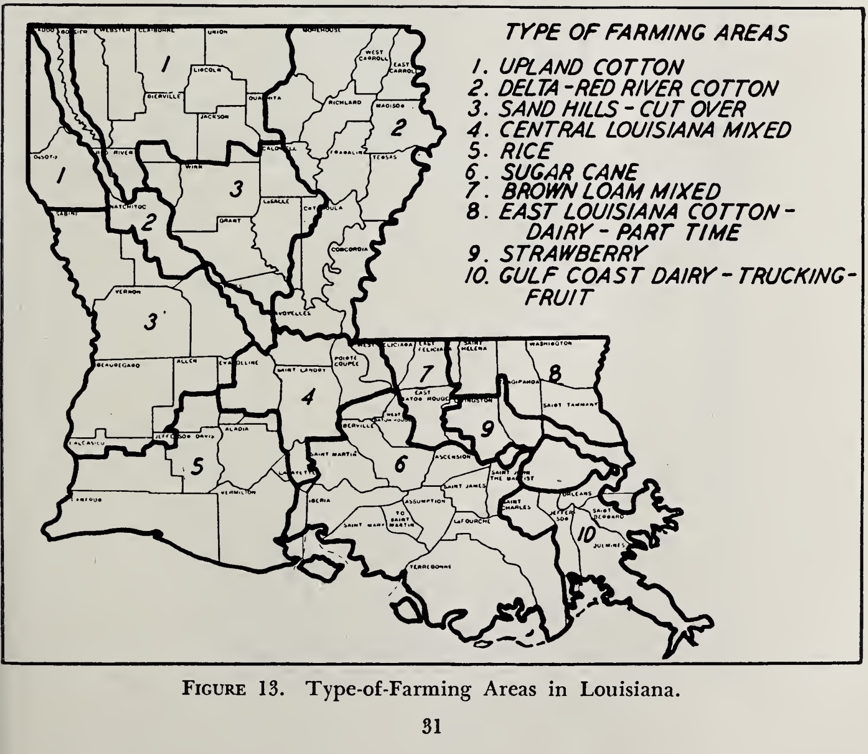
TYPE OF FARMING AREAS
1. UPLAND COTTON
2. DELTA-RED RIVER COTTON
3. SAND HILLS - CUT OVER
4. CENTRAL LOUISIANA MIXED
5. RICE
6. SUGAR CANE
7. BROWN LOAM MIXED
8. EAST LOUISIANA COTTON - DAIRY - PART TIME
9. STRAWBERRY
10. GULF COAST DAIRY - TRUCKING - FRUIT
1
2
3
1
2
3
4
5
6
7
8
9
10

FIGURE 13. Type-of-Farming Areas in Louisiana.

TABLE VII. TYPE-OF-FARMING AREAS (ON A WARD BASIS) ACCORDING TO FERTILITY, BY SIZE OF COMMUNITY AND PROPORTION OF NEGROES IN THE POPULATION

Type-of-Farming Area	Fertility Rank by Degree of Urbanity and Percentage of Negroes									
	Total					10,000 or More				
	Total	0-14 Per cent	15-29 Per cent	30-59 Per cent	60 Per cent and Over	Total	0-14 Per cent	15-29 Per cent	30-59 Per cent	60 Per cent and Over
Upland Cotton	5	9	6	5	5	..	..	..	..	..
Delta-Red River Cotton	9	3	5	9	6	6	..	..	5	..
Sand Hills-Cutover	6	7	7	7	..	..	..	..	..	..
Central Louisiana Mixed	1	6	2	1	3	4	..	..	4	..
Rice	3	5	3	6	..	3	..	..	2	..
Sugar Cane	2	4	1	3	4	2	..	..	1	..
Brown Loam Mixed	10	1	10	10	7	7	..	..	6	..
East Louisiana Cotton-Dairy-Part Time	4	8	7	2	1	1	..	1	..	..
Strawberry	7	2	4	8	..	..	..	..	..	..
Gulf Coast Dairy-Trucking-Fruit	8	10	9	4	2	5	..	2	3	..

TABLE VII (Continued)

Type-of-Farming Area	*Fertility Rank by Degree of Urbanity and Percentage of Negroes*														
	2,500 to 10,000					*Under 2,500*					*Unincorporated*				
	Total	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*	*Total*	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*	*Total*	*0-14 Per cent*	*15-29 Per cent*	*30-59 Per cent*	*60 Per cent & Over*
Upland Cotton	6	..	4	8	1	8	5	6	7	3	6	8	7	3	4
Delta-Red River Cotton	7	..	5	7	2	5	1	5	3	6	7	4	4	5	6
Sand Hills-Cutover	8	..	6	6	..	7	4	7	6	..	8	6	8	6	..
Central Louisiana Mixed	1	..	..	2	..	1	..	3	1	4	2	7	3	2	3
Rice	2	1	2	1	..	2	2	2	2	..	4	5	2	..	..
Sugar Cane	3	2	1	4	..	3	3	1	4	2	5	3	1	4	5
Brown Loam Mixed	10	..	..	10	..	6	..	..	10	5	10	1	10	8	7
East Louisiana Cotton-Dairy-Part Time	9	..	..	9	..	4	..	4	8	1	3	9	5	1	1
Strawberry	5	..	..	5	..	9	..	8	9	..	1	2	6	..	..
Gulf Coast Dairy-Trucking-Fruit	4	..	3	3	..	10	..	9	5	..	9	10	9	7	2

those used in the following analysis,[10] are indicated in Figure 13. The variations in fertility among these type-of-farming areas when cross-classified according to residence and race are shown in Table VI. Table VII was prepared to further the analysis, utilizing the smallest political subdivisions.

A study of these data leads to the following conclusions:

1. When strictly comparable residential and racial groups are compared, there are only slight differences in the reproduction rates of the various type-of-farming areas.

2. Probably because of their French population and culture, the residents of the Central Louisiana Mixed Farming, the Sugar Cane, and the Rice areas are reproducing very rapidly. On the other hand, the populations of the Brown Loam Mixed Farming, the Delta-Red River Cotton, and the Sand Hills-Cutover areas have low fertility ratios.

VI. LOUISIANA RANKS HIGH AMONG THE STATES IN FERTILITY

The people of Louisiana are among the most fertile in the nation. This is true for both white and Negro residents of small villages, the towns, and the farms of the state. Only the population of urban Louisiana fails to reproduce at a rate far in excess of the average for the nation. (See Tables VIII and IX and Figures 14, 15, and 16.)

Louisiana's rural-farm population stands high in the rate at which it is reproducing. While this is true for both races, Louisiana's white farm people rank especially high in comparison with those of other states. (See Tables VIII and IX.) The white farming population in Louisiana ranks twelfth among all states and third among the Southern States in the rate at which it is reproducing. Her Negro farm population ranks fifth among the Southern States, where rural-farm Negroes are numerically important.

The high rates of reproduction characterizing the farming population of Louisiana are evident from a study of Figures 14, 17, and 18. But although the rate of reproduction among the rural-farm white population in Louisiana shows up comparatively high, fertility among large portions of the population living in the Rocky Mountains, in the Dakotas, and in the central and southern Appalachians is decidedly higher. The high rates of reproduction characteristic of the delta parishes and portions of southern Louisiana stand out in Figure 17. Only the farming populations surrounding the largest cities in this state have fertility rates as low as those characterizing the northeastern states, the central states, and the states bordering upon the Pacific Ocean.

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[10] The classification of farming types used here is based upon a study made by the Louisiana State University Department of Agricultural Economics. For purposes of this investigation, the Delta Cotton Area was combined with the Red River Delta Cotton Area, and the Sand Hills was combined with the Cutover Area.

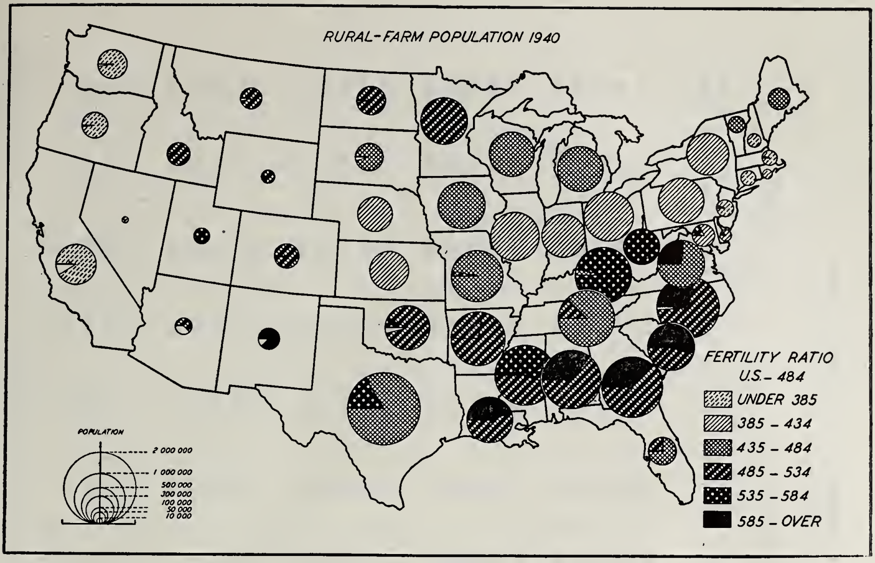

FIGURE 14. Fertility Ratios of the Rural-Farm Population of the United States, by Race and Residence, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line; the proportion of "other races" by the segment starting at nine o'clock and moving counterclockwise to the heavy line. Where either racial group constitutes less than one per cent of the total rural-farm population, its proportion is not shown.)

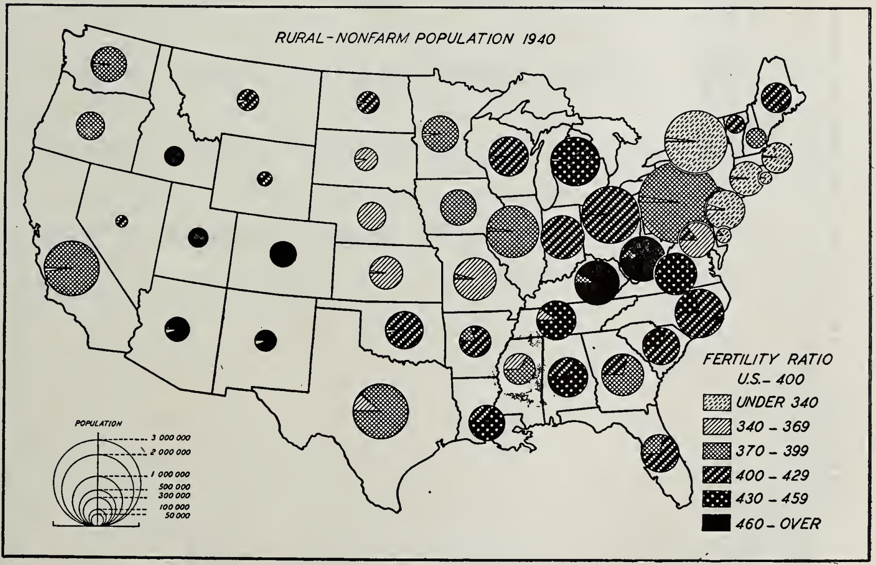

FIGURE 15. Fertility Ratios of the Rural-Nonfarm Population of the United States, by Race and State, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line; the proportion of "other races" by the segment starting at nine o'clock and moving counterclockwise to the heavy line. Where either racial group constitutes less than one per cent of the total rural-nonfarm population, its proportion is not shown.)

TABLE VIII. THE 48 STATES RANKED ACCORDING TO FERTILITY, BY RESIDENCE AND RACE, 1940

The States	*Total*				*White*				*Negro*			
	Total	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*
Alabama	11	25	11	5	9	24	10	7	16	25	27	16
Arizona	3	4	6	1	8	4	6	6	6	8	15	4
Arkansas	10	37	22	12	6	33	17	5	19	42	38	30
California	43	43	37	42	43	44	36	42	40	30	24	43
Colorado	23	17	7	16	21	18	7	11	34	31	16*	34*
Connecticut	46	42	48	48	46	42	48	48	36	7	48	48*
Delaware	40	36	42	39	41	37	43	39	33	29	39	38
Florida	34	44	25	19	34	43	22	21	35	43	35	28
Georgia	14	29	29	10	18	25	30	13	17	35	28	17
Idaho	5	3	4	15	4	3	5	9	12	46*	14*	23*
Illinois	42	41	38	35	42	41	37	35	47	37	37	31
Indiana	31	13	26	38	31	13	26	37	45	19	46	46*
Iowa	25	12	36	28	25	12	35	28	27	6	18*	13*
Kansas	32	18	43	34	32	20	42	33	39	15	45	37*
Kentucky	7	23	5	7	3	19	4	3	38	44	36	33
Louisiana	19	34	14	6	22	36	11	12	18	27	25	18
Maine	22	6	17	29	20	6	14	29	7*	1*	9*	9*
Maryland	37	35	39	32	40	38	40	38	29	17	30	20
Massachusetts	44	30	44	45	44	31	44	45	37	16	23*	29*
Michigan	30	11	8	27	29	11	8	25	44	21	43	24*
Minnesota	27	24	28	19	28	26	31	17	9	18	1	7*
Mississippi	6	40	35	9	10	32	28	15	14	40	42	21
Missouri	35	45	40	30	35	45	39	30	46	39	31	32
Montana	16	10	12	18	19	10	18	19	2	3*	4	6
Nebraska	29	21	41	33	30	22	41	31	31	24	12*	26*

TABLE VIII (Continued)

The States	*Total*				*White*				*Negro*			
	Total	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*
Nevada	24	20	13	31	26	21	15	32	8	14*	11*	14*
New Hampshire	33	14	34	44	33	15	34	44	20*	9*	33*	1*
New Jersey	47	46	47	47	48	47	47	47	42	22	41	36
New Mexico	1	2	1	2	1	2	1	1	4	28	3	5
New York	48	48	45	40	47	48	45	40	48	48	47	44
North Carolina	12	26	18	8	11	27	16	14	15	26	22	12
North Dakota	9	9	21	13	7	9	24	8*	1	13*	2*	3
Ohio	38	28	23	37	36	30	25	36	43	23	29	42
Oklahoma	17	19	20	14	14	17	21	10*	22	34	21	22
Oregon	39	47	33	41	38	46	32	41	25	36	13*	40*
Pennsylvania	41	32	30	36	39	34	29	34	41	20	32	45
Rhode Island	45	31	46	46	45	35	46	46	22	4	17*	39*
South Carolina	4	16	15	3	13	23	20	18	11	12	19	11
South Dakota	13	8	31	23	14	8	38	23	3	2*	6	8
Tennessee	20	33	9	22	12	28	9	20	32	41	44	27
Texas	26	22	27	24	24	14	27	27	30	47	40	25
Utah	2	1	2	4	2	1	2	2	10	38*	10*	10*
Vermont	18	7	16	25	17	7	13	22	28*	5*	33*	47*
Virginia	21	39	10	21	22	40	12	26	21	33	20	19
Washington	36	38	32	43	37	39	33	43	24	32	8	41
West Virginia	8	27	3	11	5	29	3	4	26	45	26	35*
Wisconsin	28	15	19	26	27	16	19	24	13	11	5	15*
Wyoming	15	5	24	17	16	5	23	16	5*	10*	7*	2*

*Based upon less than 1,000 females aged 15-44.

TABLE IX. THE TWELVE SOUTHERN STATES RANKED ACCORDING TO FERTILITY, BY RESIDENCE AND RACE, 1940.

Southern States	*Total*				*White*				*Negro*			
	Total	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*	*Total*	*Urban*	*Rural-Nonfarm*	*Rural-Farm*
Alabama	5	4	4	2	3	4	3	3	4	2	5	3
Arkansas	4	9	8	8	2	9	7	2	7	9	9	11
Florida	12	12	9	9	12	12	9	10	11	10	7	10
Georgia	7	6	11	7	9	5	12	5	5	6	6	4
Kentucky	3	3	1	4	1	2	1	1	12	11	8	12
Louisiana	8	8	5	3	9	10	4	4	6	4	4	5
Mississippi	2	11	12	6	4	8	11	7	2	7	11	7
North Carolina	6	5	7	5	5	6	6	6	3	3	3	2
South Carolina	1	1	6	1	7	3	8	8	1	1	1	1
Tennessee	9	7	2	11	6	7	2	9	10	8	12	9
Texas	11	2	10	12	11	1	10	12	9	12	10	8
Virginia	10	10	3	10	9	11	5	11	8	5	2	6

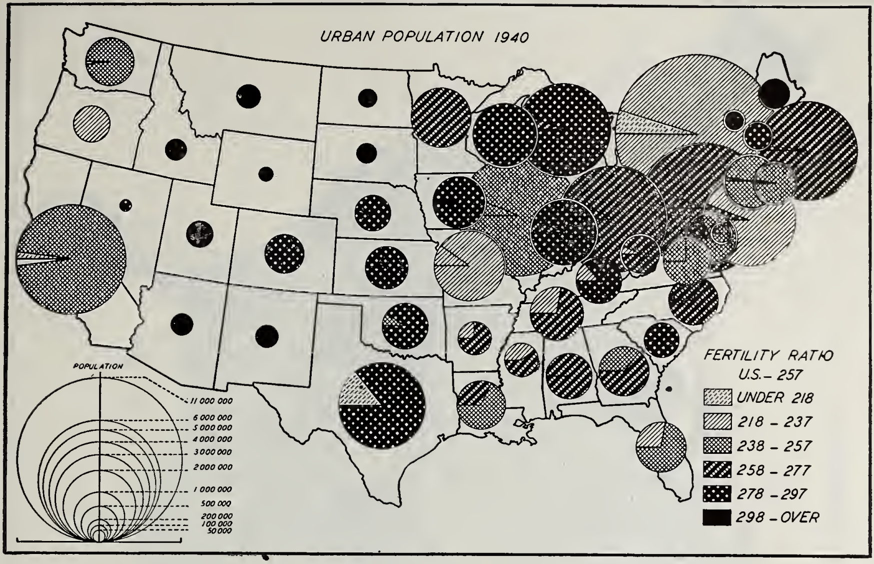

FIGURE 16. Fertility Ratios of the Urban Population of the United States, by Race and State, 1940. (The proportion of Negroes is indicated by the segment starting at nine o'clock and moving clockwise to the heavy line; the proportion of "other races" by the segment starting at nine o'clock and moving counterclockwise to the heavy line. Where either racial group constitutes less than one per cent of the total urban population, its proportion is not shown.)

The variations in the fertility of rural-farm Negroes throughout the United States also are very great. The extremely high fertility of those in southern Louisiana is striking. Only for isolated counties in other southern states are rates of reproduction as high. On the other hand, the fertility of the Negroes residing in the Mississippi Delta is among the lowest in the entire region.

Louisiana's rural-nonfarm population also ranks relatively high in fertility. The state's whites rank eleventh among all states and fourth among the Southern States. The rural-nonfarm Negro population of this state ranks fourth among the Southern States, i.e., in the region where rural-nonfarm Negroes are numerically important. White rural-nonfarm residents throughout the New England, Middle Atlantic, East and West North Central, and Pacific States have lower rates of reproduction than those in Louisiana. Even in the Southern States, only in Kentucky is the white rural-nonfarm population distinctly more fertile than that of Louisiana. Among the Negroes the fertility of Louisiana's rural-nonfarm population is exceeded only in Virginia and the Carolinas.

Louisiana's urban residents, on the other hand, rank low in fertility. This is true for both whites and Negroes. (See Tables VIII and IX and Figure 16.) The fertility of the white residents of Louisiana's cities places them thirty-sixth among those of all states and tenth among those

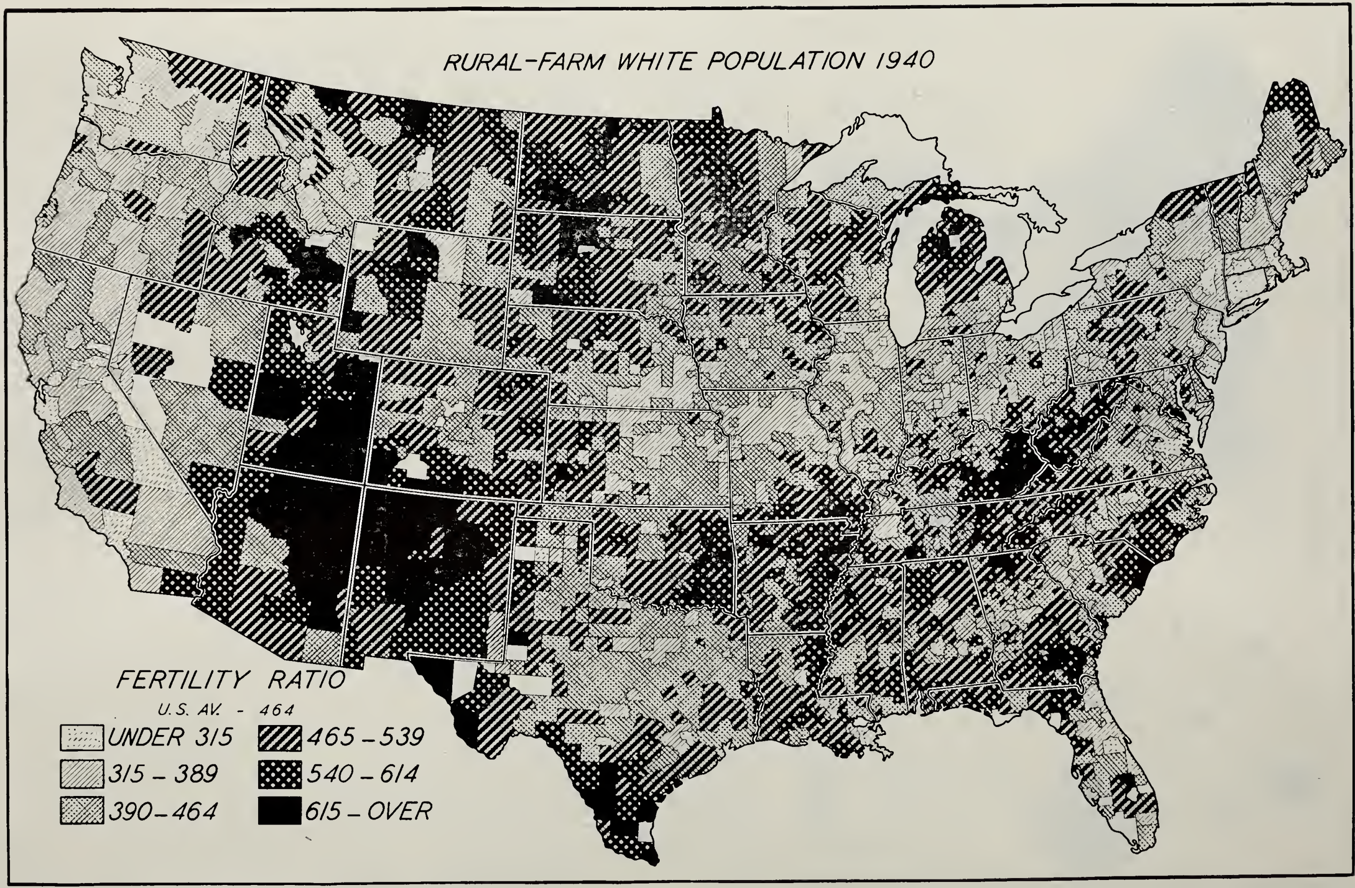

FIGURE 17. Fertility Ratios of the Rural-Farm White Population in the United States, by Counties, 1940. (Counties having less than 100 rural-farm white women aged 15-44 are left blank.)

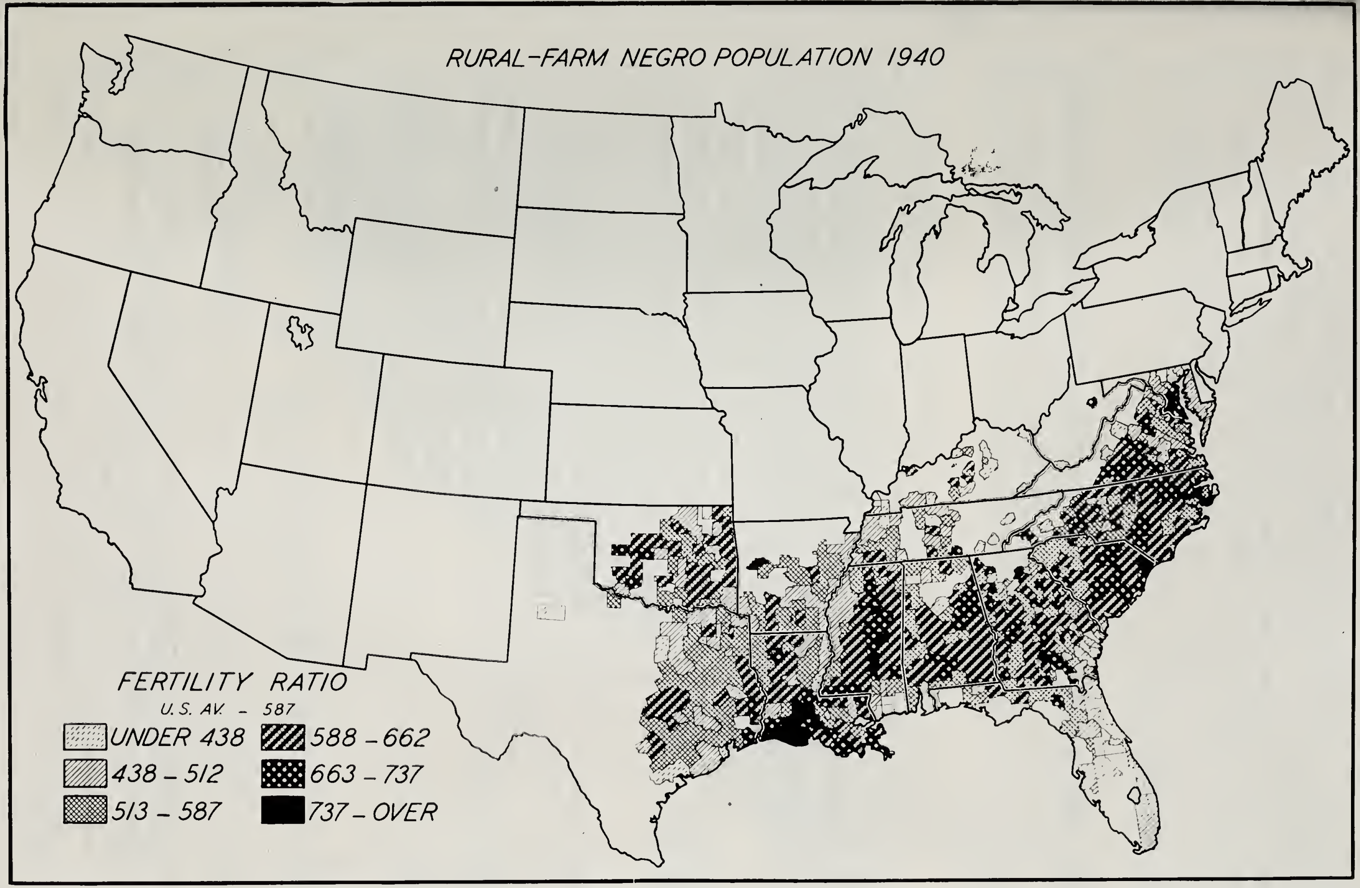

FIGURE 18. Fertility Ratios of the Rural-Farm Negro Population in the United States, by Counties, 1940. (Counties in the 15 Southern States for which data are available but which have less than 100 rural-farm Negro women aged 15-44 are left blank.)

of the Southern States. Urban Negroes in this state rank twenty-seventh among those of all states and fourth among the Southern States in rate of reproduction. The low rank of Louisiana's urban people is due in large part to the fact that 48 per cent of her urban whites and 50 per cent of her urban Negroes reside in the large city of New Orleans. In general, states having few large cities or a small urban population rank high in fertility, while those with large, dense urban populations rank well down the scale.

VII. THE RATE OF REPRODUCTION IS FALLING RAPIDLY

The rate of reproduction in Louisiana is decreasing rapidly. This tendency is true for both whites and Negroes in each of the residential categories.

In the sixty years from 1880 to 1940, the rate of reproduction for the total population decreased drastically, or from 727 to 386. The precipitous fall in the rate of reproduction was about equally fast for whites and Negroes. (See Figure 19.) With the exception of an increase in fertility between 1890 and 1900 on the part of the white population, rates of reproduction among both races declined with each successive decade.

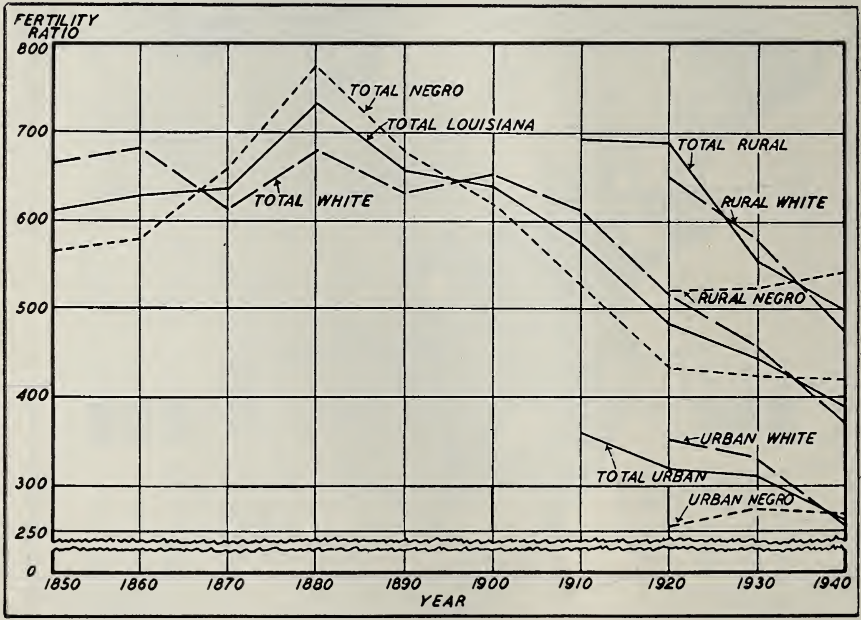

Figure 19. Trends in Fertility in Louisiana, by Race, 1850-1940; and by Residence, 1910-1940.

In 1920 the white population, rural and urban, had much higher fertility ratios than the Negroes. Negroes thronged to the cities more rapidly than the whites, so that their total rate of reproduction fell rapidly. However, the rates for rural Negroes and urban Negroes held their own, and by 1940 they were both above the corresponding ratios for members of the white race.

The falling rate of reproduction in Louisiana is not peculiar to this state alone. Rather, decreasing rates of reproduction have been general throughout the United States and appear to characterize modern civilization. (See Figures 20 and 21.) There is reason to believe that the decline, which lagged in Louisiana in comparison with the nation, will continue for several decades to come.

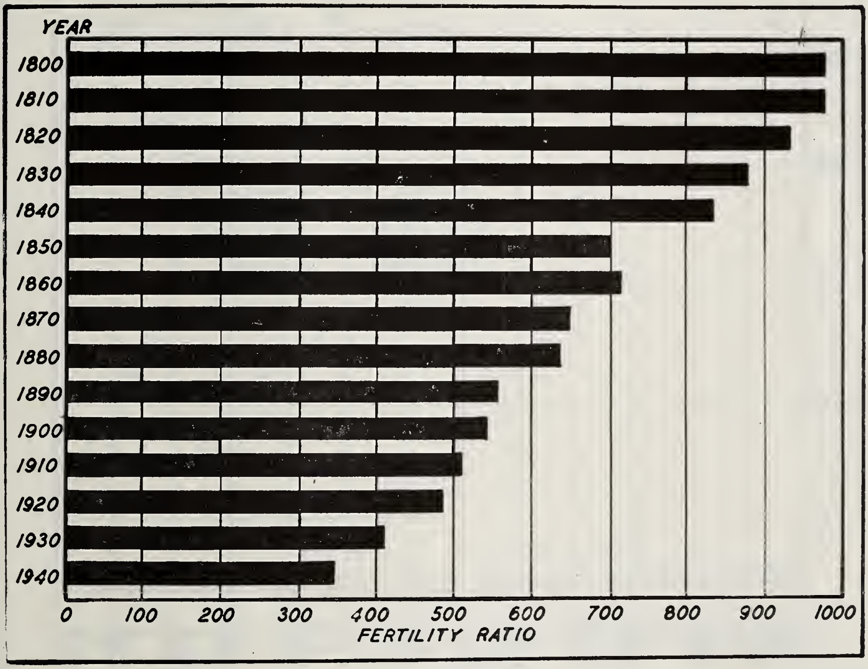

FIGURE 20. Trends in Fertility in the United States, 1800-1940.

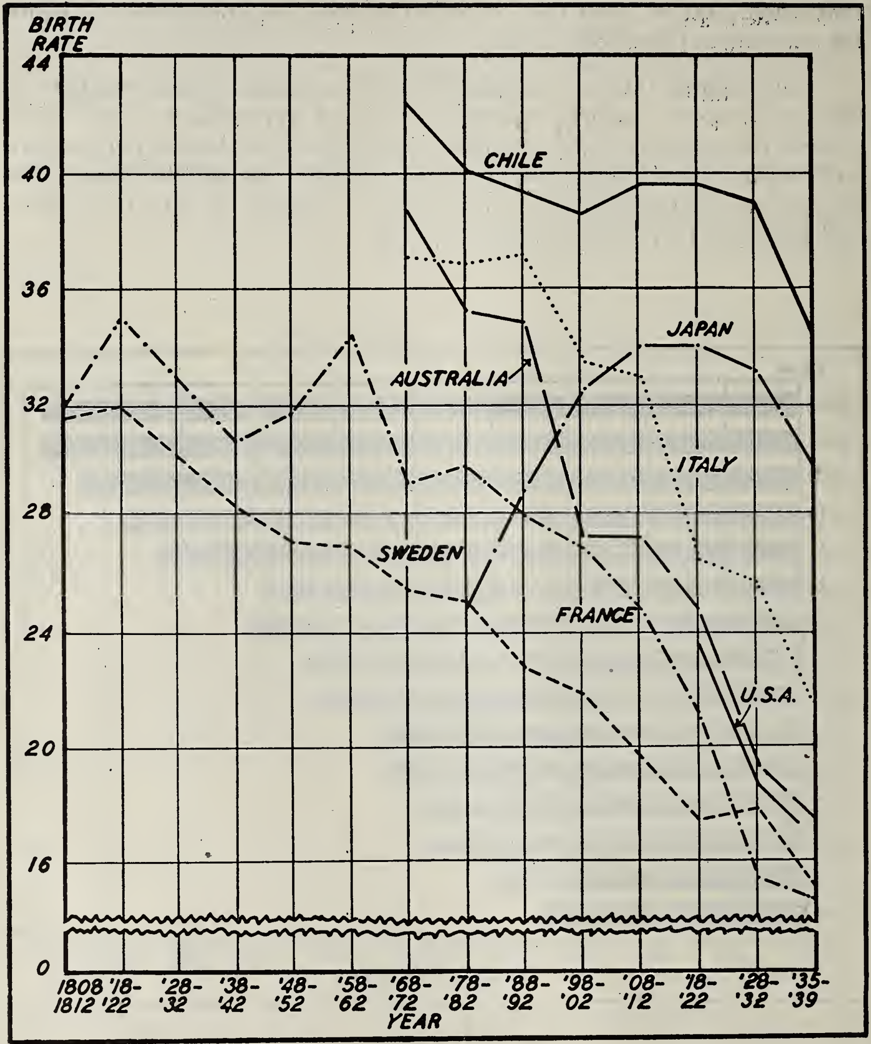

FIGURE 21. Trends in the Crude Birth Rates of Selected Countries, 1808-1940. (Source: Warren S. Thompson, *Population Problems,* 3rd ed., New York, 1942, p. 152.)

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FREEZING FOODS FOR HOME USE

By

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FREEZING FOODS FOR HOME USE

By SOCRATES KALOGEREAS

Public interest in frozen foods has increased rapidly in recent years. This is true not only for commercially frozen products, but also for those prepared in the home and held in frozen locker storage. Also, a number of manufacturers of refrigeration equipment are making small freezers which may be used for the freezing and storing of foods in the home. In view of the extremely rapid growth of the frozen food industry, the locker plants, and the so-called farm freezer, a consideration of the basic principles of preservation by freezing has been undertaken in this bulletin.

Freezing has become a highly preferred method of preserving many foods, not only because it is a satisfactory, sanitary, and economical method, but also because it is quick and easy for the homemaker, and in addition, frozen foods come out of storage prepared for cooking or serving. Freezing of foods is important in that products possessing fresh qualities are made available at unusual times and places at practically usual prices. Properly handled frozen meat, fish and vegetables when cooked compare favorably with fresh ones. Frozen foods retain more nutritive value than do those preserved by any other method. Nevertheless, unless foods are carefully handled before freezing, some of their value may be lost in preparation.

PRODUCTS SUITED FOR PRESERVATION BY FREEZING

Freezing, contrary to canning, does not prevent spoilage of food by killing microorganisms except in rare cases, but it does prevent undesirable changes in food through microorganisms, enzymes and cell respiration by lowering their activities to a minimum. Since all these processes develop more easily and possess higher activity in food products after harvesting, it is important to maintain cleanliness during preparation and complete the freezing process as soon as possible after harvesting.

Not all food products are suitable for freezing. In general, vegetables which are commonly served raw as a salad are unsuitable for freezing because freezing (together with blanching) impairs the fresh flavor and destroys crispness. This is the case with cantaloupes, celery, cress, cucumbers, endive, lettuce, green onions, parsley, radishes, green peppers, tomatoes and watermelons. Because of other methods of preservation that are peculiarly suited to them, many vegetables are not recommended for freezing. These include artichokes, cabbage, herbs, onions, hot peppers, white potatoes and rutabagas. Vegetables especially suitable for freezing are peas, beans, corn, spinach, collards, turnip greens and kale. Carrots, parsnips, asparagus, cauliflower, mushrooms, rhubarb and beets are also suitable for preservation by freezing.

The characteristics of fruits which influence freezing qualities are stability of color and flavors on exposure to the air. Most fruits are well suited to preservation by freezing. In those instances where whole fruits do not give a satisfactory frozen product, better results are obtained in the form of slices or pulp. Pears and bunch grapes are almost the only fruits that are not recommended for freezing. On the other hand, there appears to be little or no justification for the freezing storage of bananas, citrus fruits, and prunes of the dry varieties, as there are other means of preservation equally satisfactory.

Freezing preservation is the only commercial method of keeping the fresh qualities of juices. The process of preserving acid juices in most cases is simpler and less expensive than preserving the product itself. Apple juice, citrus fruit juices, grape juice, the juices of various berries, and the juice of tomato and rhubarb are considered acid juices.

The fact that freezing storage preserves the natural fresh qualities of meats for longer periods of time than other commonly used methods is the specific reason that freezing of meat is so extensively used at present. Besides, freezing meat kills nematodes, tapeworms, and a high percentage of bacteria, and by the formation of ice in the tissue helps in tenderizing it. Other products which are usually preserved by freezing are fish, poultry, game, milk products and eggs. Details on their methods of preservation will be given later in this bulletin.

FREEZING METHODS

The length of time required for food to become frozen solid depends upon method of freezing, type and size of container, nature of product being frozen, and quantity placed in the freezer at one time. Methods range from slow freezing such as that accomplished by the ordinary mechanical refrigerator or freezer locker to very rapid freezing by immersion in a freezing liquid (brine or sugar solution). The main difference in foods frozen at different rates is in the size of ice crystals formed within the tissues. Slow freezing induces the formation of large crystals. By slowing down the rate of freezing, ice crystals may be increased in size as much as 500 times and the larger ones may range up to 1,000 times the size of the cells. The formation of large crystals results in an enormous amount of crushing and rupturing of cells and upon thawing makes the food soft, increases the loss of juice by drip or leakage and creates favorable conditions for enzymes to act upon cell contents, causing changes in color and flavor of the product. Firmness, low leakage and retention of color and flavor are desirable qualities for a food preserved by freezing, and these can better be accomplished with quick freezing. An exception is the case of fruits packed with sugar. Here quick freezing as actually practiced, has little advantage over slower methods because of the need for sugar penetration into the fruit. Since the purpose of this bulletin is to explain home freezing, it will not deal with the various processes of quick freezing as they are applied by the industry, but will give directions for the freezing operation, and preparation of the products to be frozen, in individual freezers or in the local frozen food locker plants.

The simplest type of locker plant is that which offers only cold storage service. The customer places the food to be frozen directly in the locker and allows it to freeze and remain there until it is desired for use. A better arrangement is one in which the locker operator maintains a sharp freezer (a room held at 0° to —10° F.) in which the foods are frozen prior to placement in the lockers. Many locker plants of this type offer butchering, meat cutting, packaging, and freezing services, but very few have services for preparation and packaging of fruits and vegetables.

A number of types of farm freezers are being used. These vary from rather large "walk in" freezers to refrigerated cabinets as small as $2\frac{1}{2}'$x$2\frac{1}{2}'$x7′. Many of the "walk in" types of freezers have an outer room maintained at a little above freezing which is used for cool storage of fresh fruits, vegetables, and dairy products. The cabinet type is the size which appeals to most farmers and homemakers. The simplest type of cabinet consists of a rectangular, insulated box maintained at approximately 0° F. by means of a small refrigeration unit. This type has the disadvantage of causing the previously frozen stored foods to thaw partially while fresh foods are being frozen, if the fresh foods to be frozen are placed in the same cabinet. In some cabinets this condition is avoided by having two separate compartments, one for freezing and another for storage. Usually a somewhat lower temperature is maintained in the freezing compartment than in the section in which the products are stored. Some two-compartment cabinets have been constructed in which forced air circulation is provided in the freezing compartment. This materially increases the rate of freezing and insures a uniform temperature throughout the freezing compartment, provided the products are not solidly packed in the freezer. Another type of freezer has one or more refrigerated metal plates on which the products are placed for freezing. Since it is accepted that quick freezing is always the best, the two-compartment freezers and locker plants provided with a sharp freezer offer better conditions for freezing, if the temperature of the freezing units is sufficiently low to secure a satisfactory quick freezing. But it should be kept in mind that the rapidity with which a product freezes does not necessarily depend on the temperature of the freezer alone. Some of the other factors that affect the rapidity with which a given product freezes are: size, shape and arrangement of packages, air circulation, contact with the metal freezer plate, previous treatment, temperature of the product to be frozen, and quantity of the food to be frozen at one time. By combining all these factors in the most favorable combination for quick freezing, best results can be obtained from any type of freezer. Starchy foods as peas, corn, and lima beans show very little drip; therefore rapid freezing in these products is not as important as with the non-starchy products. Although higher temperatures may prove satisfactory for freezing certain foods, in most cases a temperature of —25° F. is needed and should be preferred if available. In general, storage temperatures above 0° F. have not proved satisfactory for the preservation of many products for long periods of time as rancidity may develop in the fat in pork meat and loss of color and vitamin C in fruits and vegetables may occur.

Fluctuating temperatures in frozen storage where meat and poultry are maintained, cause a rapid deterioration of the quality of the products because these fluctuations speed up dessication, or loss of moisture. They also accelerate crystal growth in the frozen product and consequently increase drip or leakage when the product is thawed. Fluctuation in temperature is caused by limited area of cooling coils, frequent opening of the door, poor insulation, overloading with food to be frozen and power or mechanical failure. The storage cabinet or locker should not be opened during a power failure. Usually the cabinet is well insulated so that the food does not thaw if the freezing machinery is out of operation for 12 to 72 hours. If a long, continued power failure is expected, dry ice may be procured from the nearest ice cream manufacturer. Fifty pounds of dry ice will prevent thawing in a home freezer for a day or two.

The size of the storage cabinet varies greatly according to the needs or size of the family. In general, an eight cubic feet capacity freezer for the average farm family is considered sufficient. In one cubic foot of space there can be stored about 35 to 45 pounds of food. The cost of operation per year of one 15 cubic foot size cabinet stored in a cool cellar was $16.50, the power consumption averaging about 125 kilowatt-hours per month.

CONTAINERS

In selecting containers for packaging foods to be frozen, the most important considerations are that they be practically moisture-vapor-proof, odorless, and tasteless. Paraffined cardboard cups and tubs are in common use for frozen foods, particularly for foods packed in brine or syrup. Various types of cartons with or without cellophane or moisture-vapor-proof bags are also used (Figure 1). When additional moisture-vapor-proofness is desired, an overwrap of heavy waxed paper may be applied to the rectangular carton. This overwrap, as well as the bag, is sealed with a hot iron (Figure 2). When the food is to be stored only a short time, the container is less important. The cellophane bag alone may be used if there is little handling which might cause tearing. Ordinary waxed paper is not suitable for wrapping foods to be frozen.

Glass jars may be used as containers for frozen foods. It is best to use them for fruit or a food that will be thawed before its removal from the container. Old lids with rubbers are satisfactory, as a perfect seal is not necessary. Allow at least one to one and one-half inch headspace for expansion of the food on freezing.

Tin cans are another possibility for packing foods for freezing. As in canning, use enamel lined cans for colored foods.

Meat, poultry and game are wrapped in locker paper or cellophane. Butcher paper does not give adequate protection from moisture loss or exposure to air. Stockinette material, sold in pound rolls, makes a good covering for cellophane or locker paper as it keeps the wrapping material tight against the food. The preferred method of wrapping meat when vapor-proof paper or cellophane is used is the drugstore or con-

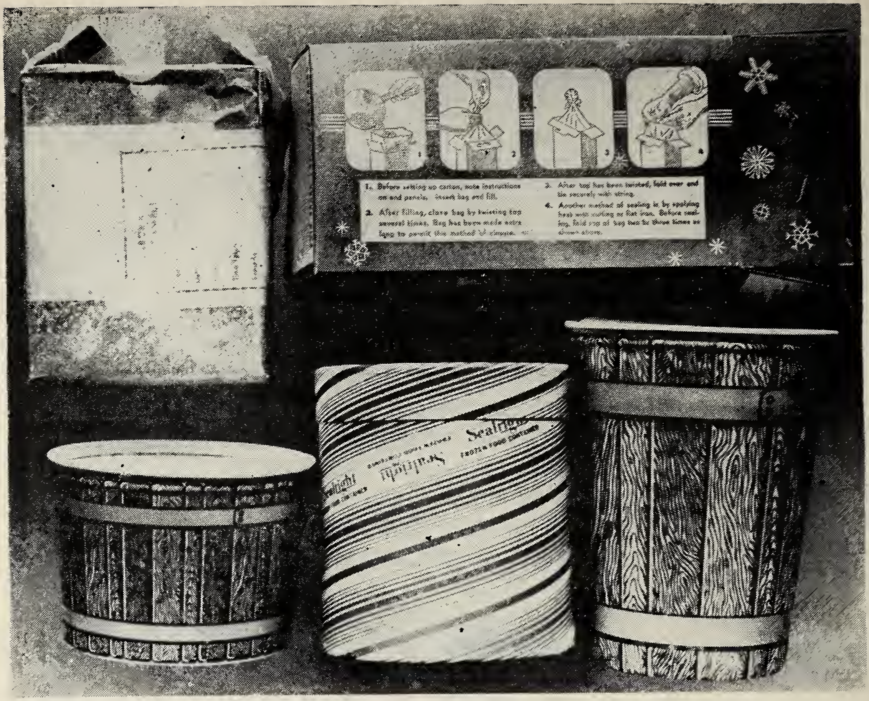

FIGURE 1. Packages for Frozen Fruits and Vegetables

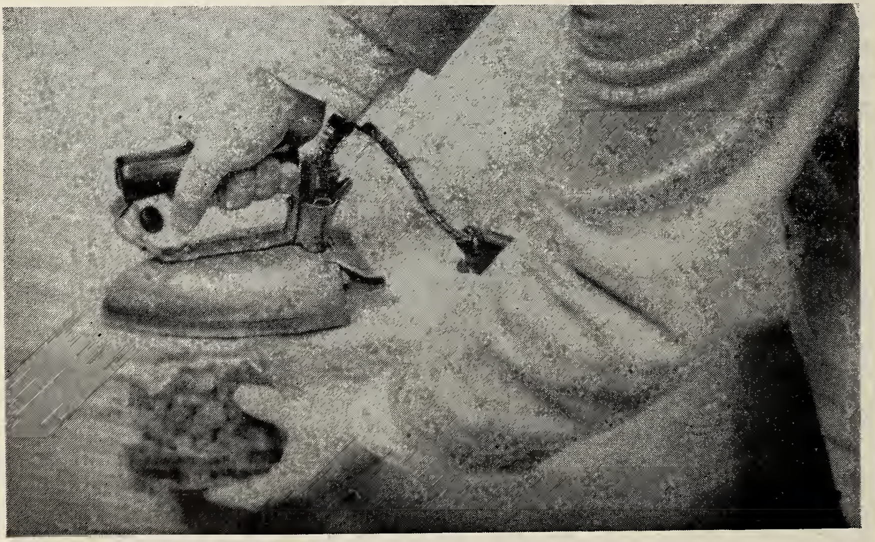

FIGURE 2. Sealing a Cellophane Bag Containing Strawberries

fectioner's wrap. The meat is placed in the center of a square piece of paper large enough to make a locked fold of two opposite sides. The ends are folded twice so that the folds are locked and no air pockets are left. String or gummed tape is passed over the ends to hold the paper together and against the meat. If locker paper, which is less vapor-proof, is used, the butcher's wrap is desirable, as there are more layers of paper for protection. To pack, place paper on table in a diagonal position with a point toward the person wrapping meat and with waxed side up. Place meat in center, bring lower point of paper over meat, then the two side points to the center, and roll meat tightly in paper. Fasten securely with string or gummed tape.

GENERAL CONSIDERATIONS IN THE PREPARATION OF FOOD FOR FREEZING

Products should be selected at the best stage of maturity for serving or cooking. The object of freezing at low temperatures is to stop all the natural life processes and hold the product as nearly as possible in the state in which it enters the freezer. Freezing of course will not improve a poor product. Fruits and vegetables for freezing should be selected for freshness, appearance, flavor, texture and adaptability for freezing under local conditions. They should be sorted and washed, and all nonedible parts removed as is done in preparation for the table. They should be prepared ready to serve or cook without further handling, especially if they are to be cooked without thawing. They should be harvested when mature, fully colored and flavored, but not overripe, mushy, or moldy.

All vegetables must be blanched (scalded) before freezing except sweet peppers and rhubarb, which, on account of their acidity, are classed with the fruits. Blanching is necessary in order to stop the natural processes of growth and decay. These life processes are greatly retarded by freezing but cannot be checked completely unless the enzymes have been inactivated by heat. If the vegetables have not been thoroughly blanched, they will soon lose their attractive color and develop unpleasant flavor and odor. Although harmless to health, the product becomes as undesirable for food as any aged and faded fresh vegetable. Blanching produces a brighter color, softens the product, and makes packing easier. Some unblanched vegetables also become tough in storage. The time of blanching varies with the product. In general one to two minutes in boiling water or several minutes in steam is needed. The temperature of blanching should not be lower than 185° to 194° F. Some products, such as corn and peas, deteriorate rather easily after blanching, while others, such as carrots and asparagus, are more resistant. The best insurance of quality vegetables is an adequate blanching.

The greatest hazard in home freezing is in overloading the freezer, since, in such case, food may actually begin to spoil before it becomes frozen or cooled to the point where bacterial growth is retarded. Overloading may also result in thawing of products already frozen and in storage in the same cabinet.

The question of refreezing of foods already thawed should also be considered here, since it can happen as a result of damage to the supply of current or in the function of the freezer. This point is important not only from the standpoint of the nutritive value of the food but also from the point of health, since refrozen completely defrosted vegetables and shellfish are likely to harbor food spoilage microorganisms which produce toxin even at relatively low temperatures. In regard to home-frozen foods, there is no reason why thawed fruits should not be refrozen for later consumption. Meats, poultry, fish and vegetables are not acid and are consequently subject to putrefactive spoilage. It is unwise to refreeze either vegetables or shellfish which have become completely defrosted. Meat, poultry and fish may be either eaten immediately or refrozen without danger, provided the temperature of these products has not at any time exceeded 50° F.

Sliced fresh peaches, apricots and apples darken very rapidly on thawing. For this reason such products may require treatment with sodium sulfite or ascorbic acid or may require blanching to retard or inactivate oxidizing enzymes.

THAWING AND COOKING FROZEN FOOD

If frozen fruit is to be cooked before using, it need not be thawed. Berries for desserts are served while a little ice still remains in the fruit. Such fruits as peaches, apricots and apples require more thawing than do berries. Fruit for pie and cobbler must be thawed enough to spread, and fruit for shortcake, pudding and ice cream must be partially thawed. During thawing, fruit should be left in the unopened, original container.

Thin steaks, chops and cutlets may be cooked without thawing, but steaks as thick as one and one-half inches should be either partially or completely thawed. Pork that contains much fat is better cooked without thawing in order to avoid development of an early state of rancidity. Poultry should be at least partially thawed before cooking, and fish may be completely or partially thawed. To thaw fish, place the unopened container in the refrigerator, because there is less leakage with slow thawing. Fish should be cooked while still chilled, because it spoils quickly. Eggs, milk, butter, cream and cheese should be thawed completely and used as when fresh.

Vegetables in the frozen state are usually added to a small amount of boiling water and cooked from one-third to one-half as long as fresh ones. If they were packed in brine, some thawing is necessary, as the liquid frozen with the vegetable serves as the cooking water. Asparagus and broccoli, which are cooked in less than enough water for covering, may be thawed enough to break the stalks apart. Greens should be cut or broken into pieces so that uniform cooking takes place. It is necessary to thaw corn on the cob; otherwise the kernels will be cooked before the cob is thawed. Frozen vegetables are partially thawed by allowing them to stay in the sealed container about one hour at room temperature or four hours in the refrigerator. Partial thawing reduces the cooking time, as less time is required for the water to boil again after they are added. Completely thawed vegetables shrink while cooking and are generally less attractive. They may also have changes in flavor and less ascorbic acid (vitamin C) than do the ones cooked without thawing or after partial thawing. To obtain the best product in regard to palatability and nutritive value, use a small amount of water and avoid overcooking frozen vegetables.

When frozen vegetables are cooked in a pressure saucepan they should be thawed enough to be broken apart; otherwise, because of the short cooking period at a high temperature, the center of the block may still contain ice crystals after the outside is cooked. Use only enough water to keep the vegetable from burning; because of the frost on frozen vegetables this amount is about two-thirds as much as for fresh vegetables. The time of cooking varies with the vegetable and the individual's taste. In general, frozen vegetables are cooked one-third to one-half as long as fresh ones.

Since foods when frozen require a shorter cooking time than when fresh, they may be as high in nutritive value as when cooked fresh, because of smaller cooking losses. Frozen vegetables after cooking contain greater quantities of vitamins than canned vegetables, and considerably greater quantities than cooked dehydrated vegetables.

CARE OF THE HOME FREEZER UNIT

It is not necessary to defrost a freezer as often as a regular refrigerator. Usually two to three times a year is sufficient. To defrost, lift up the covers and scrape off the frost. Scoop it out with a dust pan and wipe with a towel. At least once a year, when the food supply in the freezer is low, the locker should be cleaned. First, remove all packages and put them in the freezing compartment of the home refrigerator, or pack the packages in a lined box in which some dry ice has been placed. Then turn off the electricity and open the freezer, allowing it to warm up. Wash out the freezer with a solution containing two tablespoons of baking soda to one quart of water. Do not use soap. Allow the freezer to remain open until thoroughly dry. When the freezer is dry, close the door and turn on the electricity. Replace the packages when the temperature is near 0° F.

PREPARATION OF VEGETABLES FOR FREEZING

Vegetables for freezing are prepared as for cooking, blanched and packed dry or with brine. Vegetables should be harvested while they are at their peak of flavor and appearance. It is better to use them slightly immature than overripe as the latter become tough in texture and rapidly lose flavor.

Blanching is necessary for practically all vegetables in order to stop enzyme action, which causes the food to be less attractive and of lower

TABLE 1. Preparation and Scalding or Blanching Time in Boiling Water* for Vegetables To Be Frozen‡

Vegetable	*How to Prepare*	*Scalding Time (Minutes)*	
Asparagus	Cut into lengths to fit package or in 1-inch lengths	Small spears Medium spears Large spears	3½ 4 4½
Beans, green	Pick when filled but before becoming dry		1
Beans, Lima	Pick when pods are well filled but when seeds are green	Large seeds Small seeds	2 1
Beans, snap	Use young tender beans. Snap ends and cut into 1-inch lengths		2½
Beans, Soy	Scald pods containing beans to simplify shelling. Shell	Scald to remove seeds	2½
Beets	Remove tops and roots, slice or dice. Mature beets should be cooked, then peeled and sliced	Under 1½ in. diam. Over 1½ in. diam. Cook until tender	2½
Broccoli	Select compact heads (without blooms) cut in 1-in pieces	Small Large	3 5
Brussels sprouts	Select dark green compact heads	Medium Large	4 5
Carrots	Select young tender carrots, cut in ¼-in. slices		3
Cauliflower	Choose solid white heads, cut in 1-in thick pieces	Small pieces Medium pieces	3 4
Chinese cabbage	Cut crosswise of head to 1-in. thick slices		1½†
Corn on cob	Husk and eliminate over-and under-mature ears, trim tips	Small ears Medium ears Large ears	6½ 8½ 10½
Corn, cut	Choose corn before starchy and hard but not soft. Scald corn on cob, then cut corn from cob		3
Eggplant	Peel, slice 1/3 in. thick		4
Kale	Select young tender plants, use leaves only		1½
Mustard	Discard stalk and use only tender leaves		1
New Zealand Spinach	Young tender leaves only		1½
Okra	Remove stem, freeze whole or slice after scalding		2-3
Peas	Shell, and discard hard starchy peas		1
Peas, field	Shell, and discard dried ones		1
Pumpkin	Peel, cut, cook in pressure cooker or in covered kettle on rack over water	Cook until done	
Spinach	Use tender leaves		1½
Squash, summer	Use young squash, slice ½ in. thick		3½

Vegetable	*How to Prepare*	*Scalding Time (Minutes)*
Squash, winter	Peel and cut in pieces	Cook until done
Swiss chard	Select tender leaves	2
Turnip greens	Select young, tender leaves only	1
Turnip roots	Choose tender roots, peel and dice 1/2-in. cubes	1 1/2

*After scalding for the time indicated, vegetables should be cooled immediately by immersing in cold running water.

†Cool in 2 per cent citric acid solution to prevent discoloration.

‡Adapted from table by Clarence W DuBois, "Freezing Fruits and Vegetables," *Electricity on The Farm,* August, 1943.

nutritive value. The two methods of blanching are immersion in boiling water and by steam. Since facilities for blanching in live steam are not available in the home, the hot water method is recommended. Scalding in hot water saves time and insures a more uniform product.

For the boiling water method of blanching, the kettle must be large enough to hold at least one gallon of water per pound of produce; more water is desirable for bulky vegetables such as greens. Place vegetables in a long-handled collander, wire basket or cloth bag; immerse product in rapidly boiling water; begin counting the cooking time from the time when the water again comes to a full rolling boil; blanch for the required period of time. During the blanching period agitate the vegetable by moving the container up and down in the boiling water. The length of blanching time and preparation are given in Table I. For steam blanching, use a very large kettle of six- to twelve-quart capacity which has a tight fitting cover and can be fitted with a wire rack and basket. One to two quarts of water are poured into the bottom of the kettle and the water brought to the boiling point. Then the produce is placed in the wire basket on the rack in the kettle and the vegetables are blanched in steam instead of being completely immersed in the boiling water. Blanching should be strictly limited to the necessary time if losses of vitamins and solids are to be reduced as much as possible.

A simple rough test for determining the accurate time for blanching is the so-called peroxide or catalase test, which consists of putting some pieces of the blanched tissues in a tumbler and adding hydrogen peroxide and noting whether bubbles of gas issue from the tissue pieces (Figure 3). If no bubbling is observed, the blanching is considered sufficient except for some products like corn, which do not respond in a uniform manner to this test. Another simple test is adding to a cut surface of the plant tissue a drop of benzidine (1 per cent in 50 per cent alcohol solution) and a drop of hydrogen peroxide of 12 volume strength. The development of a blue tint indicates that the vegetable has not been sufficiently blanched.

The necessity for prompt handling between harvesting and freezing is very important. If this period is prolonged, freshness is lost, vitamins are at least partially destroyed, bacteria multiply, and other changes occur. If delays at any stage of preparation are unavoidable, the product should be kept as cool as possible short of freezing. This is especially important in the case of vegetables after they are blanched. The moisture and broken surfaces offer ideal conditions for the growth of bacteria, and vitamin losses increase rapidly. Chilling the vegetables in water after blanching should be done quickly in order to avoid further losses of soluble materials such as vitamin C, thiamine, minerals, etc. Many think it is necessary only to quick freeze vegetables in order to obtain a product of fair quality, but this is not entirely true. It is equally important, prior to freezing, to chill the vegetables rapidly down to the point where microorganisms grow very slowly and chemical and physiological changes are markedly retarded.

Vegetables are packed in containers immediately after cooling, with or without the addition of a brine solution. The advantages of using brine in packing vegetables are that it eliminates drying out when the container is not vapor-proof, helps some soft foods such as asparagus, broccoli and cauliflower to hold their shape after blanching, protects food before being carried to the locker, and prevents thawing while being brought back home. Disadvantages of packing with brine are the

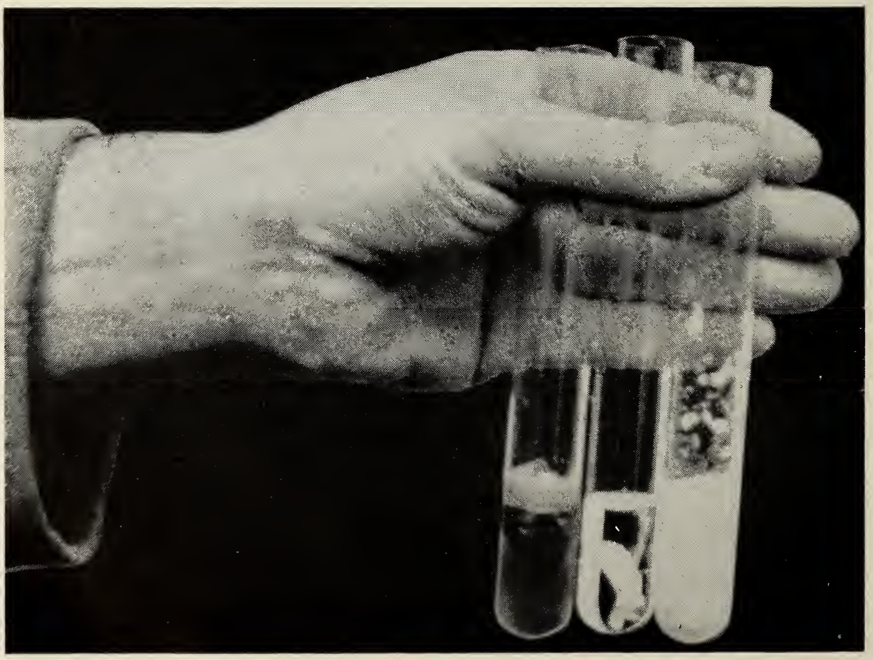

Figure 3. Test for Catalase (in the Right) and Peroxidase (in the Left) in order to Find the Proper Time for Blanching. In the Middle, Plant Tissue Well Blanched; It Neither Produces Foam with Hydrogen Peroxide (As the Right Tube) Nor Turns Blue with Benzidine (As the Left Tube).

extra work in preparation, the added weight of the packages, the danger of causing packages, especially jars, to break while freezing, and the need of thawing before cooking. In general, there are only slight differences in most vegetables packed with or without brine. Corn cut from the cob and packed in brine is superior to that packed dry. Green beans and wax beans are likely to split when packed in brine. To prepare a brine solution, add one teaspoon table salt to each cup of water, making the solution approximately two per cent. Too much salt causes the vegetable to become tough. Pack the vegetable into the container and then add enough brine to cover, allowing a headspace for expansion of the liquid on freezing.

After bringing vegetables home from the locker they should be kept in the freezing compartment of a refrigerator until just before they are cooked. Spoilage is likely to occur very quickly in thawed, uncooked vegetables.

Additional Notes on the Preparation of Specific Vegetables

Corn.—Usually a better product is obtained if the corn is cut from the cob, but it may be frozen cream style, whole kernels or on the cob. For corn on the cob, wrap each ear separately in moisture-vapor-proof paper or cellophane. Freeze and then pack into containers.

Pumpkin.—When pumpkin is to be used for pies, it is preferable to cook, mash and add sugar, honey or syrup to taste.

Spinach.—The best varieties for freezing are the Savoy type, but broad-leaf varieties such as Nobel may be used. To be suitable for freezing, the spinach should have a deep green color, no yellow leaves, short stem, and pleasing flavor and odor after cooking. It should be cut before flowers appear.

Sweet or Bell Peppers.—Use uniformly green varieties of glossy skin, thick flesh, tender texture, and characteristic flavor. Washing and halving or slicing are all that is required. Blanching is not necessary. The use of 2 per cent brine seems to improve the quality.

Sweet Potatoes.—Bake or boil potatoes until soft. Cool, peel and slice. Dip in a solution of one part of lemon juice to eight parts of water. Drain, roll in sugar, pack, and freeze. Sweet potatoes may also be frozen in the puree form.

PREPARATION OF FRUITS FOR FREEZING

Fruits for frozen pack should be soft ripe but not mushy. Apples should be ripe but not soft ripe, since steaming softens the slices. For the preparation of fruit for freezing, peel, pit, slice or otherwise prepare the fruit for table use and keep cool until ready for the sugar or sugar syrup. It is not necessary to use moisture-proof cartons for storage of fruits as for vegetables, but it is essential that cartons for freezing fruit be water tight. Wash fruit thoroughly in cold water, preferably containing ice, as this keeps the fruit firm. When a large quantity of fruit is to be frozen, it is better to prepare it in several lots so that there will be no delay between the various steps.

Sugar or sugar syrup is added to fruit for two reasons: The coating of syrup (prepared syrup or syrup formed from juice and sugar) protects fruit exposed to the air from oxygen, which hastens enzymic action. It also checks the action of enzymes in the fruit during the storage period. Dry sugar is added to those fruits which form juice, and syrup is added to the less juicy ones. When sugar is used, it is added to the fruit and mixed by rotating the container or gentle stirring until all the sugar is wet, then packed. Syrup is added after the fruit has been packed, allowing headspace for expansion on freezing.

Syrups recommended for fruits to be frozen are:
40 per cent syrup—2¾ cups sugar, 1 quart water.
50 per cent syrup—4 cups sugar, 1 quart water.
60 per cent syrup—6¼ cups sugar, 1 quart water.
65 per cent syrup—7¾ cups sugar, 1 quart water.

Hot water may be used to dissolve the sugar, but the syrup should be cool, preferably chilled, before it is used. One gallon of syrup is sufficient for approximately 40 one-pound packages.

Apples.—Two methods are in general use for the prevention of darkening of apples. They may be blanched or they may be treated with sodium sulfite. Peel and slice as for pies. For blanching, slice apples into cold water containing one teaspoon salt per cupful, until enough is prepared for five or six containers. Blanch the slices one and one-half to two minutes in steam or boiling water as directed for vegetables.

The other method of preparing apples for freezing employs sodium sulfite, which can be bought at the drugstore. Add one tablespoon sodium sulfite to a gallon of water and soak the apple slices for five minutes. Never use iron or copper containers and do not allow the solution to stand in the utensil after use.

Apples may be packed without sugar or with one part of sugar to four parts of fruit. Cooked apples or applesauce prepared to serve may also be frozen.

Blackberries or Dewberries.—These should be picked well ripe because the immature fruit tends to turn red on freezing and upon thawing remains hard. They are packed with 60 or 65 per cent syrup or one part of sugar to four parts of berries.

Figs.—Pack whole or sliced with 40 per cent or lighter syrup.

Juices.—Sweetened fruit juices are usually packed in enamel lined cans or glass jars or bottles. Allow ample headspace for expansion on freezing; otherwise the containers may break.

Peaches.—This fruit may be peeled by immersion in boiling water or by steaming for 15 to 30 seconds, or it may be lye peeled followed by immediate cooling in water. Unripe peaches will not peel easily under these conditions, are likely to become hard and bitter when frozen and thawed, and are more susceptible to browning. Sliced peaches are preferable to halves because of better penetration of sugar into the fruit and ease of packing container. If lye peeling is used or there is some delay in completing the freezing process, it is best to drop the peeled fruit into a weak citric acid solution (three-fourths cup lemon juice or two teaspoons citric acid per gallon of water). If this is not available, a weak salt solution helps to prevent browning during a delay. Peaches are packed with 60 to 70 per cent syrup.

The use of a 0.2 per cent ascorbic acid (vitamin C) in the syrup retards browning of peaches when they are thawed. Add one and one-half teaspoons crystalline or 8.5 grams in tablet form (thirty-five 250 milligram tablets) dissolved in a small amount of water to one gallon of cold syrup. It is possible to keep the syrup containing ascorbic acid over a period of 48 hours if it is refrigerated and not unduly exposed to air or contaminated with iron or copper.

Recommended varieties for this locality are Elberta, Hale, Belle of Georgia, Early Elberta and Hiley.

Pineapple.—Cut in wedges, slices or cubes and pack with 40 per cent syrup.

Strawberries.—Firm varieties of deep color, good texture, and rich flavor should be used. Of the locally grown varieties, Konvoy, Klondike, and Klonmore have proved quite satisfactory. They may be packed whole or sliced, but slicing gives the better product because of better penetration of sugar into the berries. Pack with one part of sugar to four or five of berries. Whole berries may be packed with 60 per cent syrup.

OTHER PRODUCTS

Eggs.—Eggs are always broken before freezing. They may be put up as whole eggs, yolks alone or whites alone. Whole eggs or yolks are stirred gently to avoid whipping in air, and one teaspoon salt or one tablespoon corn syrup, honey or sugar added to two cups of eggs or yolks. Egg whites are not stirred or treated before freezing. Pack in small containers so that the whole amount of eggs will be used at one time. One measuring cup will hold about five whole eggs, twelve yolks, or eight whites. Thawed egg whites may be stored in the refrigerator for several days, but thawed yolks can be stored only 48 hours.

Dairy Products.—Milk, cream, butter and cheese may be frozen if moisture-vapor-proof packaging material is used. Cheese should not be held longer than six months. On thawing, cheese shows a definite tendency to dry out rapidly.

Fish.—Fish are almost always contaminated by bacteria within a few hours after they are caught, and spoilage begins early, since organisms which attack fish normally live at low temperatures as compared with those which attack fruits and vegetables. In spite of this fish can be kept for several months in a condition almost as good as when they are fresh caught if they are frozen in the fresh condition and kept at 0° F. Fish should be placed on ice or in a refrigerator as soon as possible after catching. In any case, fish should never be allowed to become warm. Fish should be cleaned and prepared for cooking, then immersed in brine (one cup of salt to one gallon of water) for 20 to 30 seconds before being packed into containers or wrapped in moisture-vapor-proof material. Glazing, or coating with ice, may be done at the freezer locker plant.

Oysters, clams and scallops merely require washing in brine (one-half cup salt to one gallon of water) as preparation for freezing.

Crabs and lobsters should be cooked, cooled, and only the meat frozen.

Shrimp are always headed and may be frozen raw or cooked, with or without shell. Boil in water containing salt and any seasoning desired for eight to ten minutes. They may be packed dry, with cocktail sauce, or as Shrimp Creole.

Meat.—In general there are two groups of meat, those that should be chilled immediately after killing, such as pork and game, and those that should be allowed to tenderize five to fourteen days between the time of chilling and freezing, as beef and mutton.

Meat to be frozen should come from disease-free animals and be handled in a sanitary manner, as clean meat keeps better. The freshly slaughtered carcass should be chilled promptly to a temperature just above freezing within the first 24 hours. Pork should be cut and frozen immediately after it has been chilled. Veal should be cut and frozen the third day. Beef and lamb will be more tender if allowed to hang in a chilled room for about a week. The length of time meat and poultry will retain good flavor depends upon the temperature of freezing and storage and the kind of meat as given in Table 2.

TABLE 2. MAXIMUM HOLDING PERIODS FOR VARIOUS MEATS*

Kind of Meat	*Maximum Holding Period* *at —10° F.*	*at 0° F.*
Pork	1 year	8 months
Beef	1½ year	1 year
Lamb	1½ year	1 year
Veal	1 year	8 months
Poultry and game	1 year	8 months

* Lydia Tarrant, H. H. Kauffman, and P. Thomas Ziegler, *Freezing Meat and Poultry for Home Use,* Pennsylvania Agricultural Extension Service Circular 251, January, 1944.

For fresh tasting meat the storage period should be limited to half the maximum storage period. Storage of fat meat at 10° F. and 15° F. results in creating a rancid taste after three to five months storage.

The methods of wrapping meat are given under Containers, page 5. In the case of steaks and chops it is well to place waxed paper between the pieces of meat to facilitate easy separation before thawing. The removal of most of the bone in meat conserves wrapping material and storage space.

Poultry.—Poultry should be dressed and drawn and prepared for cooking. The birds may be cut in pieces or left whole for roasting, depending on the size and use to be made of them. Necks and backbones from several birds may be frozen together to be used for soup stock. The giblets are wrapped in locker paper and placed in the body cavity of carcasses for roasting. Poultry is wrapped in moisture-vapor-proof material according to directions given for meat. Cartons may be used for cut pieces. Poultry must be used immediately after thawing.

LABELING

All articles of frozen food should be labeled plainly, giving the contents of package, date and any other useful information. It is helpful to give the cut or type of meat and poultry and the approximate weight. Gummed labels are likely to come off, and ink will run because of contact with moisture. A china-marking pencil or ordinary color crayon is useful for labeling packages of frozen foods.

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A TWO-YEAR STUDY OF THE VITAMIN A POTENCY OF LOUISIANA MILK AND BUTTER

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A TWO-YEAR STUDY OF THE VITAMIN A POTENCY OF LOUISIANA MILK AND BUTTER

HARVYE LEWIS AND E. A. FIEGER

Dairy products have long been considered one of our most important sources of vitamin A, a food nutrient essential for health in people of all ages. The amount of this vitamin in milk and butter varies greatly according to the feed given the cows and season of the year. Back in 1941, in order to answer questions raised by the Food and Nutrition Board of the National Research Council on the importance of butter in the diet, a nationwide survey on the vitamin A potency of butter was inaugurated. Twenty agricultural experiment stations, the Bureau of Dairy Industry, and the Office of Experiment Stations all cooperated in making this survey of butter produced and marketed in different seasons of the year and in different regions.

The Louisiana Agricultural Experiment Station joined this cooperative project even though the amount of creamery butter produced in this state is small. Monthly samples were obtained from two creameries which account for about two-thirds of the creamery butter production in the state. In addition to studying the vitamin A potency of butter, milk was included in the survey. Milk samples representing twenty-eight dairy herds and six creameries were received and assayed for vitamin A each month. Since vitamin A and its precursor, carotene, are found only in the fat portion of milk, it was necessary to know the fat content of each sample. This was determined by the Babcock method. By stating the vitamin A potency in terms of a weight of fat it was possible to consider creamery milk with a standardized and usually lower fat content along with herd milk. Dairy products were analyzed for vitamin A and carotene over a period of two years.

Vitamin A in Nutrition

Vitamin A potency in food is composed of two factors, vitamin A per se and carotene, which is a yellow pigment that gives the color to butter, carrots, sweet potatoes and other foods. Carotene, which is sometimes called provitamin A, is also found in green leaves such as grass, clover, oat and rye grasses, alfalfa, spinach, mustard greens and turnip greens. In the animal body, provitamin A is converted into vitamin A. It follows that vitamin A itself is found only in foods of animal origin—butter, milk, liver, fish liver oils, and some other animal foods.

Either carotene or vitamin A or both may be utilized by the human or animal body. Chickens, rabbits and lambs utilize carotene efficiently. This is not the case with horses, cows and humans. Only a small portion of the carotene ingested is actually used as vitamin A. Since the cows' feed normally does not contain any animal source of vitamin A, it is important that they consume a sufficient quantity of carotene to maintain their own body's requirements and produce milk high in vitamin A.

Since vitamin A is stored in the body, it is not essential that the full requirement be consumed every day. An excess at one time will make up for a shortage at another. A diet low in vitamin A over a prolonged period of time, however, will induce symptoms which become increasingly acute if the diet is not improved. These symptoms of vitamin A deficiency in humans are changes in the membrane covering the eye and lining the eyelid, night blindness, and roughened or very dry skin. These conditions may be overcome by continued feeding of a normal diet.

Daily allowances of vitamin A as recommended by the National Research Council are:

Age Group	*International Units per Day*
Under 1 year	1500
1-3 years	2000
4-6 years	2500
7-9 years	3500
10-12 years	4500
13-15 years	5000
16-20 years, girls	5000
16-20 years, boys	6000
Adults	5000

The International Unit of vitamin A is a measurement used for both vitamin A and carotene.

Studies made at the Texas Agricultural Experiment Station (2) reveal the effect of a low carotene intake on the health of the cow. Usually the first symptom is night blindness. In a dim light the animal when approaching an obstacle will suddenly stop and veer to avoid it. A lack of normal alertness is usually one of the early symptoms of vitamin A deficiency. Convulsions is a symptom which sometimes appears early, after night blindness. Later results of vitamin A deficiency are complete night blindness, affection of the eyes, nasal discharge, extreme sensitivity to solar heat, swellings, especially of the legs, thighs, shoulders and neck, and harsh, dry hair coat.

A deficiency of vitamin A or its precursor, carotene, in the cow's feed has little or no effect upon milk production. The amount of the vitamin consumed does have a very marked influence on the vitamin A content of the milk. Ordinarily, the vitamin A content of winter milk is much lower than that of summer milk. Various breeds of cows differ in the ability to convert carotene into vitamin A. Guernsey and Jersey milk is deeper in color as a result of containing more carotene. In Holstein milk a greater proportion of vitamin A is present. For this reason it is not safe to judge the nutritive quality of milk on color alone. The amount of butterfat in milk influences the total amount of vitamin A, as it is found only in the fat.

Experimental

Thirty-three samples of milk and two of creamery butter were analyzed each month for vitamin A and carotene over a two-year period. One butter sample was from cream produced by cows in the northern part of the state and one from cream produced by cows in the southern part. Six samples represented milk from a creamery in each of the largest cities. Of the herd milk, six samples were from the northern part of the state, three from the central part and 18 from the southern part.

Each milk sample was taken from well-mixed milk, placed in a bottle and mailed to the laboratory. A preservative was used to prevent souring. Previous work in this laboratory showed that this preservative had no effect on vitamin A or carotene. At the same time, the cooperator reported the type of pasture and its condition, nature of roughage and concentrate which were fed, and the number of cows which freshened.

A preliminary report (1) of this study was published in November, 1944. Since that time other workers have found that the factor for converting micrograms of vitamin A into International Units of the vitamin is nearer four, instead of three and one-third as was formerly used. All the results have been recalculated using this factor, which makes the values slightly higher.

Chemical methods suggested by the Technical Committee of the National Cooperative Butter Project were used for determining both carotene and vitamin A. Fat was estimated by the Babcock test in order to calculate the vitamin A content per gram of fat as well as per quart of milk. By stating the vitamin contents in terms of a weight of fat, differences caused by varying amounts of fat in the milk may be overcome. The fat content of butter samples was also measured. As the vitamin A content in terms of a weight of butterfat was known, it was possible to draw a comparison between the milk and butter and between dairy products produced in this state and those in other regions.

Results and Discussion

Table I gives average monthly vitamin A values for herd milk, creamery milk and creamery butter. Milk from creameries contained less vitamin A per quart because the fat content had been standardized to about 3.8% butterfat. Figure I shows the monthly variations of herd milk, creamery milk and creamery butter on the basis of International Units of vitamin A per gram of butterfat.

As might be expected, total vitamin A values for dairy products were high when there was ample green pasture available, and low during the winter and extremely dry summer months. There were great differences between the individual samples of milk, but usually the same herds supplied the milk high in vitamin A each month. In the spring, milk from the southern part of the state showed a rise in vitamin A content earlier than that from the northern section. Highest average values for the whole state occurred in September, October, March, April and June. Low values were found during the months November through February. Some differences were found between monthly values for the two years. Low average vitamin A content of milk was found in July of one year and in April of the next as a result of climatic conditions affecting pastures. Hot, dry summer weather caused some of the pastures to be as brown as they were during the winter.

TABLE I. Average Vitamin A Content of Milk and Butter

Month and Year	*Herd Milk*		*Creamery Milk*		*Creamery Butter*	
	No. Samples	*I.U.* per Quart*	*No. Samples*	*I.U.* per Quart*	*No. Samples*	*I.U.* per Pound*
1943:						
October	18	2252	6	1817	2	17,731
November	22	1557	6	1137	2	11,138
December	22	1793	6	1195	2	11,712
1944:						
January	25	1474	6	1207	2	9,258
February	24	1654	6	1493	2	12,789
March	24	2515	6	2267	2	17,110
April	23	3211	6	2803	2	22,505
May	..	....	..	....	2	17,633
July	23	1391	6	1219	2	12,224
August	20	2028	6	1280	2	14,549
September	25	2622	6	2103	2	16,964
October	25	2738	6	2137	2	19,323
November	26	1890	6	1674	2	13,610
December	26	1719	6	1301	2	11,229
1945:						
January	24	1163	6	815	2	6,886
February	25	1097	5	976	2	7,920
March	24	1984	6	1432	2	12,025
April	23	1513	5	1093	2	11,068
May	24	1985	6	1855	2	16,763
June	24	2300	6	1962	2	14,574
July	23	2248	5	1981	2	18,361
August	24	2032	6	1730	2	17,600
September	24	2319	6	2075	2	19,258
Average	..	1977	..	1616	..	14,445

*International Units.

The most striking effect of pasture conditions was shown by grazing cows for one or two hours a day on fall planted oats. In Table II, the average vitamin A content of milk from cows grazed on oat pastures and those not grazed on oat pastures is shown. During the months November through April the increase in vitamin A potency brought about by the use of supplemental oat pasture was approximately 33 per cent.

In November, 1943, four of the five herds had been on oats only ten days or a week before the samples were taken. This was too short a time for the improvement in feed to be reflected in the quality of the milk,

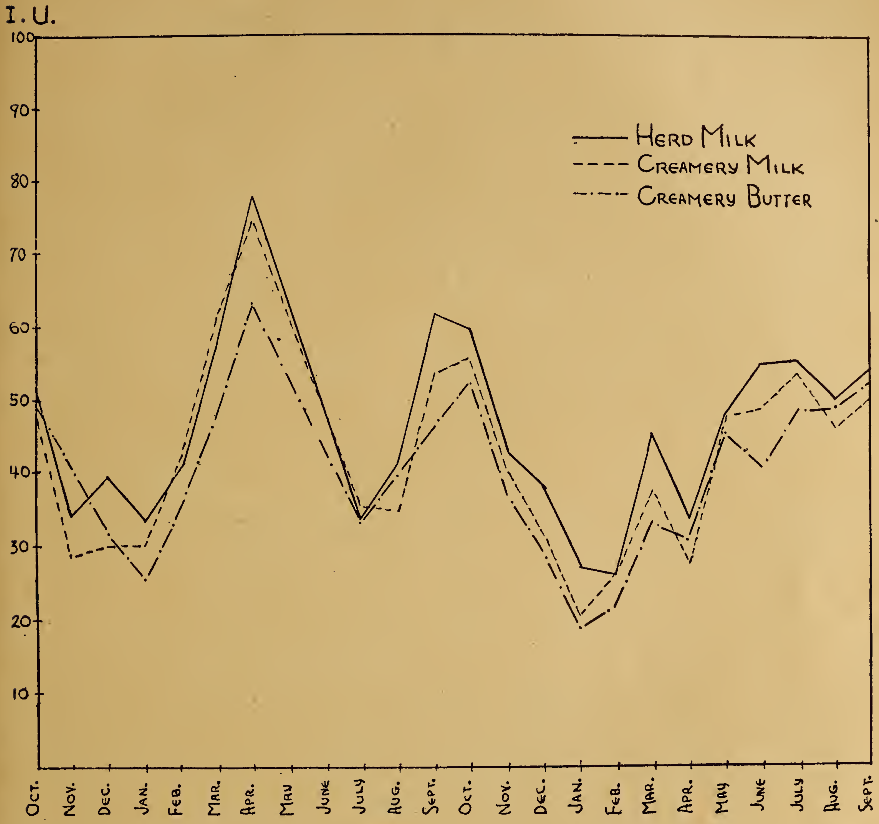

Figure 1. Average Vitamin A Content in International Units per Gram of Butterfat.

and the improvement in vitamin content did not show up until the following month, when there was a 62 per cent increase. Some observations made by sampling milk weekly from the University herd showed that two weeks or more elapsed before the milk reflected good feeding practices. It has also been observed that a decrease in carotene intake brings about a gradual rather than a sudden drop in vitamin A potency of milk.

Oat pastures grazed in December, 1943, caused a 40 per cent increase in vitamin content of milk samples analyzed in January, 1944. In March the increase was 33 per cent. Low values for February, 1944, resulted from inability to use pastures during the greater part of January because of cold, rainy weather. During March and April the grazing of clover pastures was reflected in increased vitamin A potency of milk from practically all herds. The combination of clover with supplemental oat pastures resulted in milk more potent in vitamin A than did either forage alone.

TABLE II. EFFECT OF THE USE OF SUPPLEMENTAL OAT PASTURES ON THE VITAMIN A CONTENT OF MILK

Month and Year	*Grazed on Oat Pastures*		*Not Grazed on Oat Pastures*		*Per Cent Increase By Use of Oat Pastures*
	No. of Herds	*I.U.* per Quart*	*No. of Herds*	*I.U.* per Quart*	
1943:					
November	5	1437	17	1592	—9.74
December	7	2433	15	1495	62.74
1944:					
January	4	1983	23	1412	40.44
February	5	1671	19	1649	1.33
March	5	3137	19	2351	33.43
April	6	3477	17	3118	11.51
November	7	2317	19	1732	33.78
December	10	2109	16	1476	42.89
1945:					
January	10	1702	14	779	118.49
February	13	1304	12	872	49.54
March	11	2454	13	1586	54.73
April	10	1784	13	1306	36.60
Average	..	2151	..	1614	33.27

*International Units.

In the fall of 1944 and spring of 1945 oat pastures increased the nutritive value of the milk as they did during the preceding season. The increases fluctuated from month to month depending on amount of rainfall, condition of native pastures and amount of oat pastures available.

Other feeds which caused an increase in the vitamin A content of milk were sweet potato roots and vines and clover. Only a few herds were fed sweet potato roots, but a marked increase in vitamin A content of milk followed such a practice. Clover pastures were used generally in the spring. Maximum vitamin A values in milk occurred while clover was at its height. The effect of clover pasture is shown in Table I in the high vitamin A content of milk and butter during the months of March through June. Individual samples from herds which had no clover pasture showed a vitamin A content during the spring as low as winter milk.

Vitamin A in creamery butter, the average of two samples, ranged from 6,886 to 22,505, with an average of 14,445 International Units per pound. The results of this study were included in a publication of the United States Department of Agriculture (3), along with those from other states cooperating in the study of the vitamin A potency of creamery butter. Weighted averages which take into consideration the amount of butter produced each month were calculated. A correction was made for vitamin A loss during the determination, so that the final weighted, corrected average vitamin A potency for Louisiana butter was 16,379 International Units per pound. Table III gives the vitamin A potency of creamery butter produced in 14 states taking part in the cooperative survey.

TABLE III. VITAMIN A POTENCY OF CREAMERY BUTTER PRODUCED DURING THE WINTER AND SUMMER MONTHS IN FOURTEEN STATES*

Region and Participating State	*Average Vitamin A Potency in I.U.† per Pound*		
	Winter Butter	*Summer Butter*	*Annual*
NORTH CENTRAL:			
Minnesota	10,808	17,946	14,855
Wisconsin	10,663	18,884	16,039
Ohio	9,698	15,459	13,650
Iowa	10,946	17,434	15,010
Nebraska	11,287	20,667	17,030
Kansas	11,606	15,030	13,768
Average	10,863	17,810	15,150
SOUTH ATLANTIC AND SOUTH CENTRAL:			
North Carolina	9,674	16,253	14,312
Louisiana	12,283	18,068	16,379
Mississippi	12,014	17,868	16,533
Average	11,301	17,471	15,903
ROCKY MOUNTAIN AND PACIFIC COAST:			
Washington	12,162	19,827	18,467
Oregon	12,899	18,464	16,535
California	15,140	18,968	18,241
Idaho	13,312	18,197	16,384
Montana	18,637	22,018	21,014
Average	13,931	19,170	17,754
GRAND AVERAGE	11,160	17,955	15,529

**Vitamin A in Butter*. 1945. Misc. Pub. No. 571, U.S.D.A.

†International Units.

From the work in this laboratory and studies carried on in other states, it has been proved that the vitamin A potency of milk and butter is a reflection of the amount of carotene in the cows' feed. The use of oat and rye pastures in the winter and clover in the spring is a practice which assures cows of an ample supply of the precursor of vitamin A at a time when green vegetation is scarce. Conditions other than the quantity of carotene in the ration which affect the efficiency of its utilization by the cow have not been investigated thoroughly. It is known that any condition which increases the lushness of pastures or the carotene content of silages and hays will increase the vitamin A potency of milk and butter.

The carotene content of hays varies greatly depending upon the method of curing. Alfalfa or timothy hay which is green in color has retained carotene. Silage properly made and stored contains a large portion of the carotene which was in the crop at the time it was harvested and ensiled. As carotene content decreases with maturity or loss of green color, it is important that harvesting of forages take place soon after optimum yield has been reached.

From results reported by 14 agricultural experiment stations (3), the average vitamin A potency was calculated to be 1,140 International Units per quart for winter milk and 1,800 for summer milk. Approximately 40 per cent of the milk consumed as milk or milk products is winter milk and 60 per cent is summer milk. From this, the average vitamin A potency of the milk consumed annually is 1,530 International Units per quart. In 1941 the average domestic consumption of milk in all forms was 1.052 quarts per capita per day. This amount of milk furnished 1,600 International Units of vitamin A per capita per day, or one-third of the recommended 5,000 International Units allowed for a normal adult. If, by proper feeding practices, the vitamin A potency of all milk were increased to that of summer milk, the dairy industry would contribute about 40 per cent of the national need for vitamin A.

In several instances it was found that the use of oat or rye pastures, in addition to improving the quality of milk from a nutritional standpoint, caused increased milk production. One cooperator reported a 20 per cent increase, and another a 25 per cent increase in the amount of milk produced. In these cases, the use of oat pastures benefited the dairyman not only from the standpoint of health but financially.

It is to the advantage of the farmer to use adequate, green pastures when possible and conserve the carotene in hays and other roughages at least to the extent that the cows and calves are normal and healthy. Although milk of high quality in regards to vitamin A content receives no recognition economically at the present time, the producer of such milk has the satisfaction of making a contribution to the health of his family and that of the nation as a whole.

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LOUISIANA BULLETIN NO. 406 AUGUST, 1946

A STUDY OF THE EFFECT OF FERTILIZERS ON VARIOUS CHARACTERS OF THE COTTON PLANT

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A STUDY OF THE EFFECT OF FERTILIZERS ON VARIOUS CHARACTERS OF THE COTTON PLANT

H. B. BROWN

The effect of different fertilizers on the quality of cotton fibers has been given considerable study, but the results obtained have not been very consistent or conclusive. Most of the investigators have reported that the fertilizers had no appreciable effect. The writer has had a suspicion that probably this finding was due, in part at least, to methods used. As a rule the investigator collected samples from plots in a regular fertilizer test in which the plots were large, and which was planted with seed of a commercial variety of cotton, no particular attention being paid to the position of the bolls on the plants. However, the earlier bolls developed on the lower half of the plants have longer staple than later bolls on the upper part. The soil moisture in different parts of large plots differs considerably in amount, and it has been demonstrated that an addition of moisture may tend to increase fiber length. It is also known that the plants of a commercial variety lack much of being genetically pure and that different plants in the same row may differ considerably in fiber length. Considering that the above-mentioned factors might be sufficient to affect adversely the results of fiber experiments, an attempt was made to set up an experiment in such a way that as many as possible of the suspected errors might be avoided.

PREVIOUS WORK

It appears that for cotton plants to produce fiber of normal length and strength, they must have rather favorable environmental conditions continuously. Balls[1] (1) found by measuring the lint length of the cotton in certain dated bolls of Egyptian cotton that there was a definite relation between periods of irrigation and lint length. The bolls that had lint lengthening at the time water supply was most abundant had the longest lint. A difference of nearly 2.5 millimeters was noted. The effect of the irrigation showed on the third or fourth day after watering and continued until about the tenth day.

In 1923 the writer obtained classing data from the Staple Cotton Association at Greenwood, Mississippi, on some 4,000 bales of cotton delivered by four large plantations in the Yazoo-Mississippi Delta. This was considered to be a wet year, the total rainfall being 81 inches. In 1924, which was a dry year, the rainfall being 41 inches, similar data were obtained, the variety of cotton, plantations, and classers being the same the two years. The staple averaged 1/32 inch longer in 1923.

Reynolds and Killough (2) in experiments carried on for three years at College Station, Texas, found during two years of the three that the length of fiber was positively correlated with the amount of rainfall during the time the bolls were developing.

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[1] The complete reference is given at the end of the bulletin.

Sturkie (3) of Alabama studied the effect of soil type, temperature, air humidity, rate of evaporation, and soil moisture on staple length, lint percentage, number of seeds per lock, weight per seed, and weight of lint per seed. The amount of available moisture in the soil was the only factor studied which influenced the development of lint and seed. A low moisture content caused a short fiber to be formed, reducing the length as much as $\frac{1}{8}$ inch in some cases. The critical period extended 16 days after blooming. Favorable soil-moisture conditions produced heavy bolls with long lint, heavy seed, a high lint index and a low lint percentage. Sixteen hundred pounds per acre of a complete fertilizer were used on all the plots. This heavy fertilization probably had a tendency to obscure the effect of soil type.

Afzal and Ahmad (4) of India considered that the number of flowers and bolls produced was not correlated with the rainfall and quantity of water supplied or the method of irrigation but that yield was so correlated. A slight increase in water supply improved mean fiber length and increased the percentage of mature fibers.

Warner (5) of South Carolina reported that cotton plots receiving ammonia and potash without phosphorus fruited slowly during the first part of the season and reached their peak late. Plots receiving phosphorus and potash but no ammonia fruited much earlier.

Buie (6), also of South Carolina, obtained results similar to Warner's. Phosphorus hastened fruiting. Nitrogen on poor soils stimulated the production of early fruit, but on rich soils had but little effect on earliness. Potash increased the number of flowers borne prior to the midseason, but slightly decreased the percentage of total yield the first picking.

Armstrong and Bennett (7) observed that small plants growing on plots of low fertility and clearly suffering from malnutrition produced lint of practically the same length as that produced by vigorous plants growing on plots of high fertility, but the uniformity of distribution of the different lengths was poorer in the poorly nourished plants. They noted, however, that the lint produced from blooms that were among the last to be retained was 1/16 to 1/8 inch shorter than that from bolls originating a week earlier. It was also observed that bolls with a long maturation period had a higher percentage of short fibers than bolls with a short maturation period.

Reynolds and Killough (2) after three years' work with plants growing on Lufkin fine sandy loam soil in Texas failed to find a significant correlation between the percentage of nitrogen, phosphoric acid, or potash used in fertilizers and the length of cotton fibers. They observed a slight tendency for potash to reduce the fiber length, but the differences were not great enough to be detected in commercial classing.

Pope (8) of Arkansas in studies on the effect of fertilizers on lint and other characters of the cotton plant made applications of a 4-10-4 fertilizer in 200-pound increments ranging from 0 to 1600 pounds per acre. The higher applications tended to increase seed weight and weight of seed cotton. The lint index showed no trend due to the fertilizer applications, but the lint percentage tended to decrease with an increase in fertilizer. Maximum and model fiber lengths, on a weight basis, barely suggested an increase in length resulting from the higher rates of fertilization, but the data on tensile strength indicated a decrease in strength from higher applications.

Brown (9) mentions that the average length of staple of 13 cotton varieties grown on poor hill land at State College, Mississippi, was 0.95 inch. The average length of the same varieties grown the same year on medium fertile valley land about one-fourth mile distant was 1.01 inches. The seed planted on the two fields was from the same bags. There were many poorly developed bolls on the hill-land cotton. These naturally had a higher percentage of shorter and weaker fibers. Well-developed bolls from plants grown on the unfertile land appeared to have as long fiber as similar bolls of the same variety on fertile land. The difference was largely brought about by the relative percentage of good and poor bolls. In another experiment it was found that 14 varieties growing on poor land had on the average 33.4 per cent lint, while the same varieties growing on rich land the same year had an average of 30.5 per cent.

Brown and Pope (10) in experiments conducted on Olivier silt loam soil at Baton Rouge, Louisiana, found under the conditions prevailing that phosphorus increased the rate of flowering decidedly during the first four weeks of fruiting, but later in the season the rate of fruiting was lower than on plots that had received no phosphorus. The early setting of fruit had a tendency to retard vegetative growth and the smaller plants made less cotton.

Turner (11) studied the effect of three different levels of potash fertilizer (20, 40, and 80 pounds per acre) on several different characters of cotton plants. It was found that each increase gave a significant increase in production. Strains of cotton with heavy foliage made the greatest response to potash, and there was a significant increase in boll size with each increase, but no significant increase in blooming rate.

Geiger (12), analyzing cotton seed grown in the Yazoo-Mississippi Delta, found that both nitrogenous fertilizer and leguminous cover crops decreased the percentage of oil in the seed but increased the percentage of ammonia. Phosphorus and potash fertilizers when used separately gave no increase in oil percentage but when used together gave a slight increase, the significance of which may be questioned. The percentage of ammonia was unaffected in either case. The different cultural practices he mentioned showed but little if any effect on oil and ammonia percentage, but the quantity produced was affected in some cases.

Wadleigh (13) of the Arkansas Agricultural Experiment Station made a study of the effect of four different levels of nitrogen supply on the growth, fruiting, seed, and fiber characters of cotton plants. The plants were grown in sand in pots in a greenhouse. A general nutrient solution was used which contained in addition to the common plant nutrients some of the rarer ones. The level of nitrogen supply in nitrate form was the essential differentiating characteristic of the solutions used, the levels being 8 parts per million for treatment No. A; 25 p.p.m. for No. B; 75 p.p.m. for No. C; and 225 p.p.m. for No. D. This was a near approach to growing the plants under controlled conditions insofar as soils, water, and fertilizers were concerned, but, on account of the plants being grown in the greenhouse, the temperature was abnormally high and the light below normal. It is possible that the last two factors affected results considerably.

Wadleigh observed that the inception of blooming induced a lower rate of growing in height. Plants receiving the least nitrogen stopped terminal growth for several weeks. The ones receiving the highest level reduced terminal growth markedly but did not cease altogether. Studies of the fruiting showed that after a plant had set a number of bolls sufficient to deplete its nitrogenous reserves all subsequently formed young bolls abscissed; and, very soon thereafter, young squares abscissed and terminal buds of fruiting branches aborted. There was no significant difference in the average number of seeds produced per boll between treatments; however, series receiving the two lowest increments of nitrogen showed a decided reduction in number as the fruiting season progressed, but for the two higher applications the opposite trend prevailed. The average weight of individual seeds increased with each increase in nitrogen application up to treatment "D," a very heavy application, which showed no increase over "C." With increase in seed weight, there was naturally an increase in boll weight. The length of lint showed a trend to increase with increase in level of nitrogen nutrition. Seeds from plants in series "A," which received but 8 parts nitrogen per million, had 17.6 per cent protein, while seed from series "D," the high nitrogen series, contained 27 per cent. It may be seen that the amount of nitrogen fertilizer used had a marked effect on the protein content of the seeds. An increase in protein content was accompanied by a decrease in oil content. Seeds in series "A" contained 29.2 per cent oil, while those in series "D" contained 24.1 per cent.

The above reviews of results from previous work on the effect of fertilizers and other environmental conditions on different characters of the cotton plant seem to show some inconsistencies, but these may be due largely to differences in conditions, especially soil conditions, where the experiments were conducted. If a particular element is already present in the soil in quantity, the application of this element in a fertilizer would naturally have but little effect. On the other hand, if the quantity of a particular element is very low in the soil, its absence may serve as such a limiting factor that other elements may not have much effect. All seemed to be agreed that a scarcity of moisture in the soil at the time the cotton fibers were lengthening tended to make them shorter.

LOUISIANA EXPERIMENTS

In 1943 a small tract of old, but fairly uniform, Olivier silt loam soil at the Perkins Road Experiment Station Farm near Baton Rouge was chosen for the cotton experiments mentioned below. This soil was naturally very low in fertility, especially in available phosphorus, a soil analysis showing but 17 parts per million. It was known that this land had not had any fertilizer for fifteen years, not being farmed at all during the greater part of that time.

On the cut, 32 small plots, each 4x8 feet, were marked off leaving vacant plots on the sides and at the ends of each. Six inches of the top soil of all the 32 plots was spaded up, put in wagons, and hauled to a pile where it was shoveled over three times, as is done with fertilizers, to mix it thoroughly. Then a layer of the subsoil a foot deep was likewise loaded into wagons and hauled to a pile and likewise mixed by shoveling. After mixing, the subsoil was put back on the plots and tamped down somewhat. The top soil was also returned to the plots. When the soil was put back on the plots, it formed low beds. On April 1 fertilizers as given in the following list of treatments were put in small furrows along each side of the plots, except that the barn manure, which was spread over the top of the bed, was worked into the soil with hoes. On April 26, D. & P. L. 6, a wilt-resistant, long-staple cotton, was planted in hills two feet apart, there being four hills per plot. The plants that emerged were thinned to two plants per hill. A perfect stand was maintained by transplanting a few plants. This was done while plants were small by taking up the plants with a mass of soil about their roots. The D. & P. L. 6 cotton had been propagated as a pure line strain since 1934 and was very uniform and pure.

Very similar methods of procedure were followed in 1944, except that a different cut of land was used. This was near the first tract and similar soil but naturally less fertile.

Each year at three different times during the blooming period all the blooms that opened on two successive days were tagged with dated tags, the idea being to use for comparison fiber and seeds from bolls that developed under the same weather conditions. Unfortunately in 1944 there was such a contrast between the plants of well-fertilized and poorly-fertilized plots that there was not as much overlapping in bloom production as was desirable. The well-fertilized plants bloomed early and the poorly-fertilized later. By the time the poorly-fertilized plants were blooming moderately well, the other plants were past their peak of blooming. This made it impossible to get as many bolls with the same date from the different treatments as was wanted.

During the season all blooms, shed squares, or flower buds, shed bolls, and open bolls were counted, and open bolls picked and weighed. The fertilizer and cultural treatments used were as follows:

1. Check—No treatment.
2. 1,000 pounds per acre of a 5-10-4 fertilizer.
3. 50 pounds nitrogen per acre from nitrate of soda.
4. 100 pounds phosphoric acid per acre from superphosphate.
5. 40 pounds potash per acre from muriate of potash.
6. 50 pounds nitrogen and 100 pounds phosphoric acid.
7. 100 pounds phosphoric acid, 40 pounds potash and 20 tons rotted barn manure per acre.

8A. 1,000 pounds per acre of a 5-10-4 fertilizer and irrigation equivalent to one inch extra rainfall per week. (When the ground was already wet, this was not applied.)

8B. 1,000 pounds per acre of a 5-10-4 fertilizer used under arid conditions. No rain was allowed to fall on the plots between June 27 and harvest time. (During April the rainfall was 3.2 inches; during May, 2.3 inches; and from June 1 to 27, 1.46 inches.)

The 8B treatment was used in 1943 only. The plots were randomized and all treatments except 8A and 8B replicated four times. There were only two plots of each of these.

The plant beds were cultivated with hoes to prevent a possible movement of fertilizer which might have happened had plows been used. Furrow slices were added to each side of each bed at every cultivation to keep the fertilizer well covered and to prevent the beds from weathering away. Cross drains were run across the cut and small levees added to prevent water from rains flowing the length of the cut past differently fertilized plots.

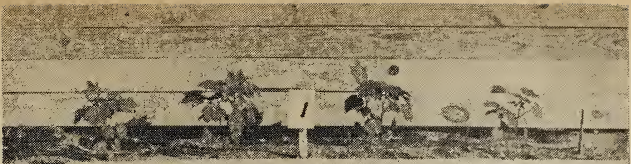
Growth of Plants

Planting was done at the normal time and under favorable soil conditions in both 1943 and 1944. Since the planting seed were treated with Ceresan, seedling diseases were largely controlled, and there was no Fusarium wilt in the plots owing to the use of a wilt-resistant variety. Perfect stands were maintained by transplanting plants in two or three hills.

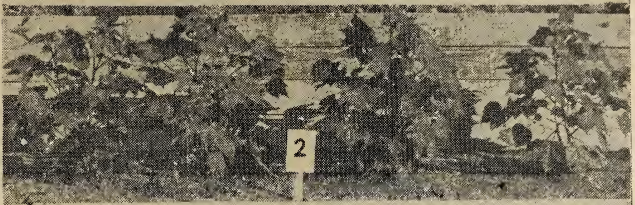
TABLE 1. HEIGHT OF PLANTS IN CENTIMETERS—JUNE 7, 1944

Treatments	*Mean Series 1*	*Mean Series 2*	*Mean Series 3*	*Mean Series 4*	*General Mean*
1	13.5	13.3	12.4	14.3	13.4
2	25.8	28.8	28.0	32.4	28.8
3	12.4	11.3	14.8	11.0	12.4
4	18.0	16.0	19.0	17.7	17.7
5	13.0	14.5	12.5	14.0	13.5
6	20.0	15.3	22.5	25.0	20.7
7	34.3	33.8	32.8	32.5	33.4
8A	....	38.3	....	30.3	34.3

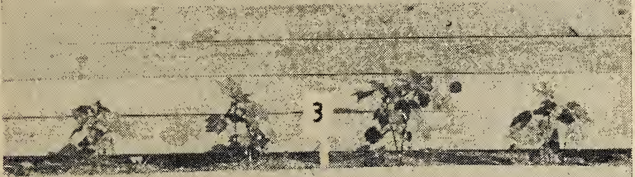
The contrast in growth following different treatments was somewhat greater in 1944 than in 1943 owing to the use of less fertile land in 1944,



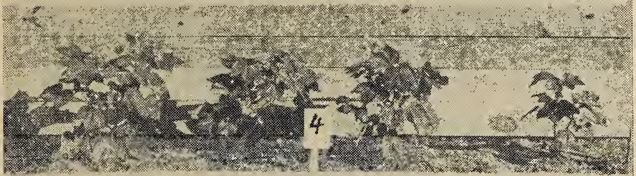
1. Check (No treatment)



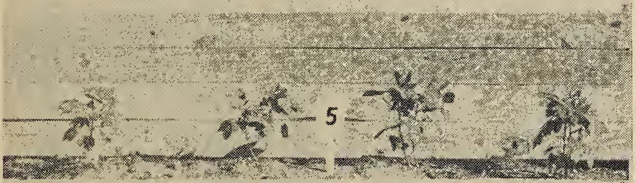
2. 1000# of a 5-10-4 fertilizer



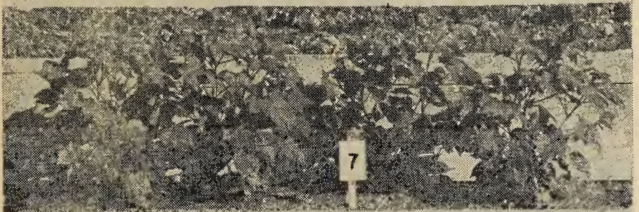
3. 50# Nitrogen



4. 100# Phosphoric acid



5. 40# Potash



7. 100# Phosphoric acid, 40# potash and 20 tons manure

Figure 1. Effect of Fertilizers on Plant Growth. (Size of Plants on June 7, 1944.)

but the general proportions were similar the two years. Certain plots were photographed on June 7. These are shown in Figure 1. The height of all plants was also measured on June 7. The means of these measurements are given in Table 1. It may be seen that, with one or two exceptions, these figures are very consistent, and they show very significant differences in the height of the plants.

Figure 2 shows graphically the comparative height of plants resulting from different treatments used and something of the relation of plant height to blooming and rate of cotton production. The plants getting treatment 1, which was the check receiving no fertilizer, made slightly more growth than the plants receiving treatment 3 (50 pounds of nitrogen per acre). This difference was too slight for it to be significant, but it does show that the nitrogen alone had no beneficial effect. This was probably due to the fact that the lack of phosphorus is such a limiting factor in this particular soil that the plants could make only slight use of the nitrogen supplied. Much the same can be said in regard to the results from treatment 5 (40 pounds of potash per acre). No significant increase or decrease over the height of the check was obtained. Treatment 4, however, did result in a significant and decided increase in height. This treat-

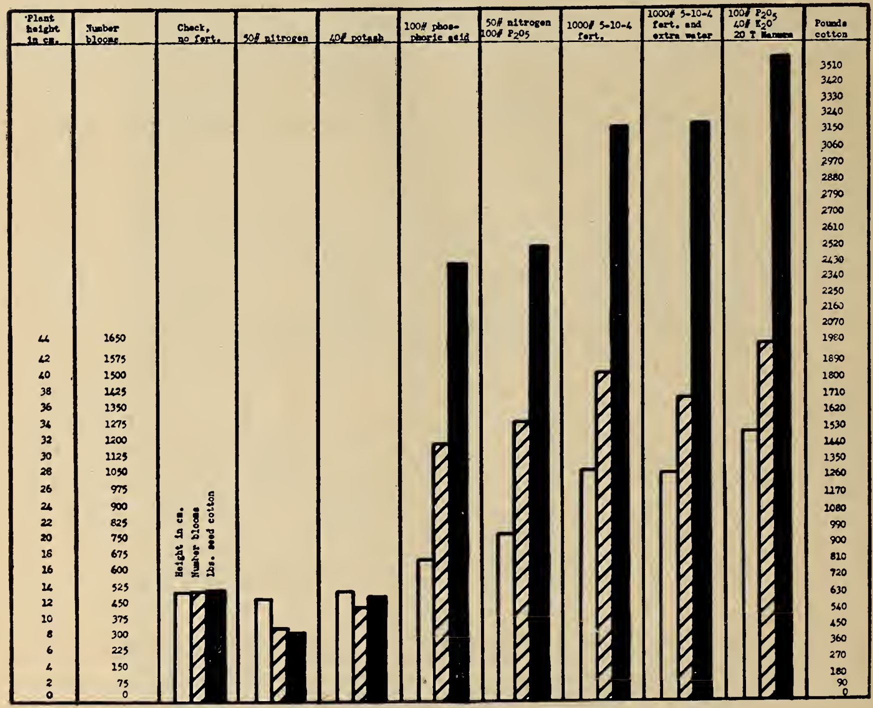


FIGURE 2. The Relation of Growth of Cotton Plants, Blooming Rate, and Cotton Production in 1944.

ment consisted of 100 pounds of phosphoric acid used alone. Treatment 6, consisting of 100 pounds of phosphoric acid and 50 pounds of nitrogen, also gave a decided increase and somewhat greater growth than the phosphoric acid alone. Treatment 2, consisting of 1,000 pounds of a 5-10-4 complete fertilizer, produced considerably more growth than treatment 6. The potash when used alone gave no increase in growth, but, when used with the nitrogen and phosphorus, it made a well-balanced fertilizer that induced additional growth. Treatment 8A was the same as treatment 2 except that some irrigation was used, an additional inch of water being applied certain weeks when the land was not wet already. This seemed to have no great effect on the growth of plants, but it did result in somewhat larger bolls and apparently slightly longer staple. Data on these will be given later. In treatment 7, the nitrogen of treatment 2 was replaced by 20 tons of barnyard manure per acre. This, in addition to giving more of the essential nutrient elements in fertilizers, supplied a considerable quantity of organic matter to the soil. This treatment induced greater plant growth.

Treatment 8B, which was used only in 1943, was like treatment 2 except that the plants were grown under rather arid conditions, no rain being allowed to fall on the plots after June 27. No height measurements were made in 1943, but apparently this treatment did not affect the height of the plants greatly—being started too late in the season—but they were more slender, had leaves of a paler green, and did less blooming and more shedding than any of the others.

Fruiting

Bloom counts were made each day during the blooming periods of 1943 and 1944. Both years the first blooms opened about June 22, and in the case of plots fertilized alike, the course and rate of blooming the two years were very similar. Figure 3 shows graphically the course during the two years for plots that received 1,000 pounds of a 5-10-4 ferti-

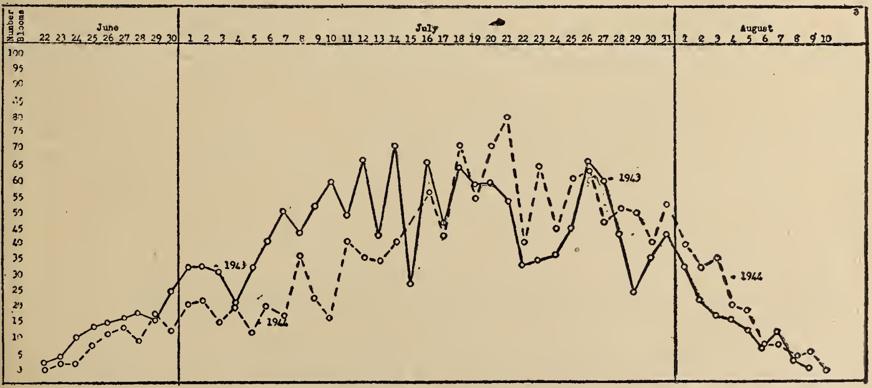


FIGURE 3. Blooming Curves for Seasons 1943 and 1944 for Plots Receiving 1,000 Pounds of 5-10-4 Fertilizer.

lizer, the number of plants and the spacing being the same for both sets of plots. The blooming rate during the first half of the season in 1943 was somewhat better than in 1944, but during the latter half it was lower. So, on the whole, there was not much difference. Blooming ceased about August 10 both years. It is probable that the advantage in earliness in rate of blooming in 1943 was due to the use of land that was naturally somewhat more fertile. Other experiments have indicated that a more fertile soil is conducive to earlier blooming. The difference in seasonal effect the two years was apparently not great.

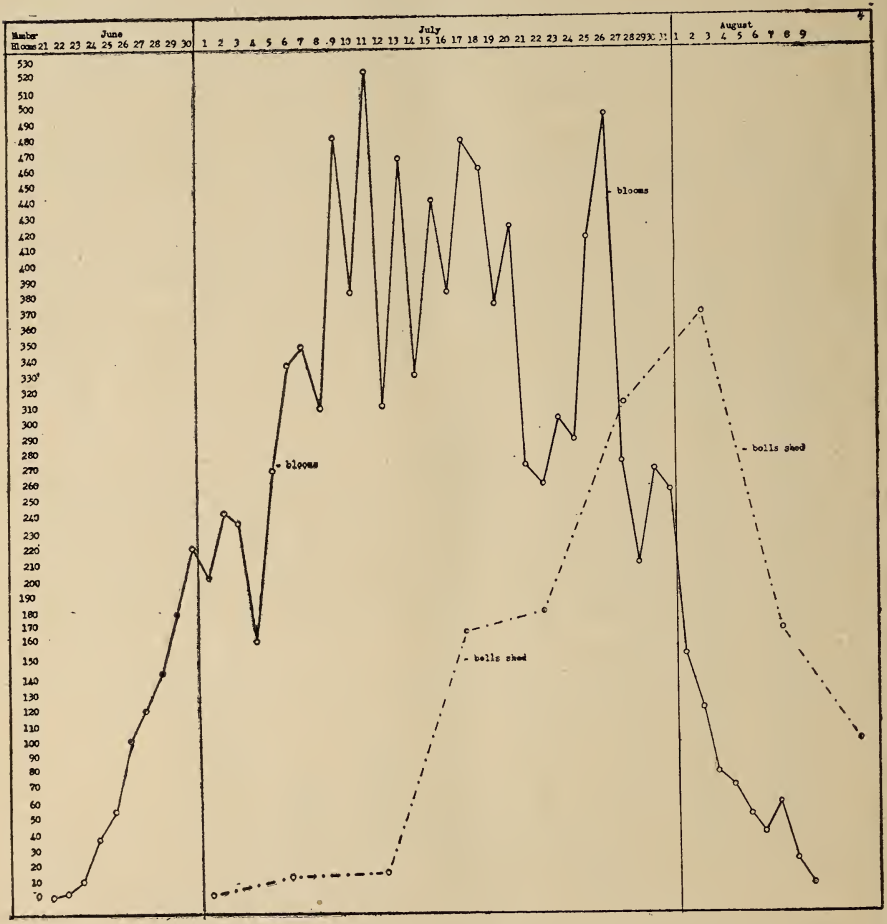


FIGURE 4. Blooming and Boll Shedding on all Plots, June 21 to August 9, 1943.

Figure 4 shows the total daily blooming rate for all the 32 plots for the season of 1943. It will be noted that beginning June 21 there was a steady, daily, upward climb in the number of blooms until the month of July was reached. During July there were both periodic and daily fluctuations. The periodic fluctuations, each covering a few to several days, were rather irregular and were probably due to weather changes. The daily fluctuations during the time that the plants are blooming freely have doubtless been observed by everyone who has made bloom counts throughout the blooming season, but no one has offered a satisfactory explanation. Ewing (14) made a study of the relation of various factors of weather to cotton fruiting—maximum and minimum temperatures, soil moisture, relative humidity, and the amount of sunlight received by the plants—but was able to see no close relation between the daily bloom rate and the weather factors just mentioned. It appears that there is an up and down rhythm in the metabolism of the plants that results in more blooms one day than the next. The cause of this rhythm is not known but there appear to be one-day periods of temporary exhaustion. Beginning on July 27 there was a steady and rapid reduction in the total number of blooms produced on the plots. This was due partly to boll weevils puncturing squares but more to the plants' reaching a limit, under their growing conditions, to their power of fruit production. The boll weevils were controlled by putting poison on the plants and by hand picking and destroying all punctured squares. Figure 4 shows that there were but few blooms after the first of August and no bolls set.

In 1944, as was mentioned previously, the soil used was less fertile naturally and the plants that received no or unbalanced fertilizers made much less growth and were later in blooming. This resulted in somewhat less blooming for the season as a whole and a prolongation of the blooming period in August. The last blooms were counted on August 23. The rate of blooming, however, began to fall the first of August. Aside from the two points just mentioned, the blooming curves for the two years were similar.

Figure 4 shows also the boll shedding for the year 1943. It will be observed that up to about July 18, the period that the plants were young and vigorous and did not have a heavy load of large bolls to support, the shedding rate was low but after that date the rate of shedding climbed rapidly and about July 28 the shedding rate became higher than the blooming and so continued the rest of the season. No bolls were set after July 28. In 1944 the boll shedding curve was comparatively low until about July 26, when it began a rapid ascent, and exceeded the blooming rate about August 1. No bolls were set after that date. As a rule, in south Louisiana, with cotton planted at the normal time, but few good bolls are to be expected after August 1. Further discussion of blooming and shedding of both bolls and squares will be given for each fertilizer treatment.

Effect of Different Fertilizer Treatments on Fruiting

Figure 5 indicates the rate of blooming, boll shedding, and square shedding on four unfertilized plots during the season of 1944. All numbers are for weekly periods. As was mentioned previously, this land was naturally unfertile and without fertilizers could not be expected to make large or very productive plants. By examining Figure 5 it will be noted that a limited amount of blooming occurred during the week of June 28. Following this there was a slow but gradual upward climb until the week of August 9, when the peak was reached. After this there was a rather rapid reduction in rate, but there were still some defective blooms being produced when bloom counting was stopped on August 23. None of these late flowers made bolls. Boll shedding was low during the first six weeks of flowering but made a gradual increase during that time. About August 2 the boll shedding began to increase rapidly and equalled the blooming rate by the week of August 16. Boll shedding continued high during August. Square shedding was low until about August 9, when an abrupt upward climb was started. Square shedding continued during the rest of the season at a heavy rate. As was mentioned previously, a considerable part of this shedding was due to boll weevil punctures in late squares.

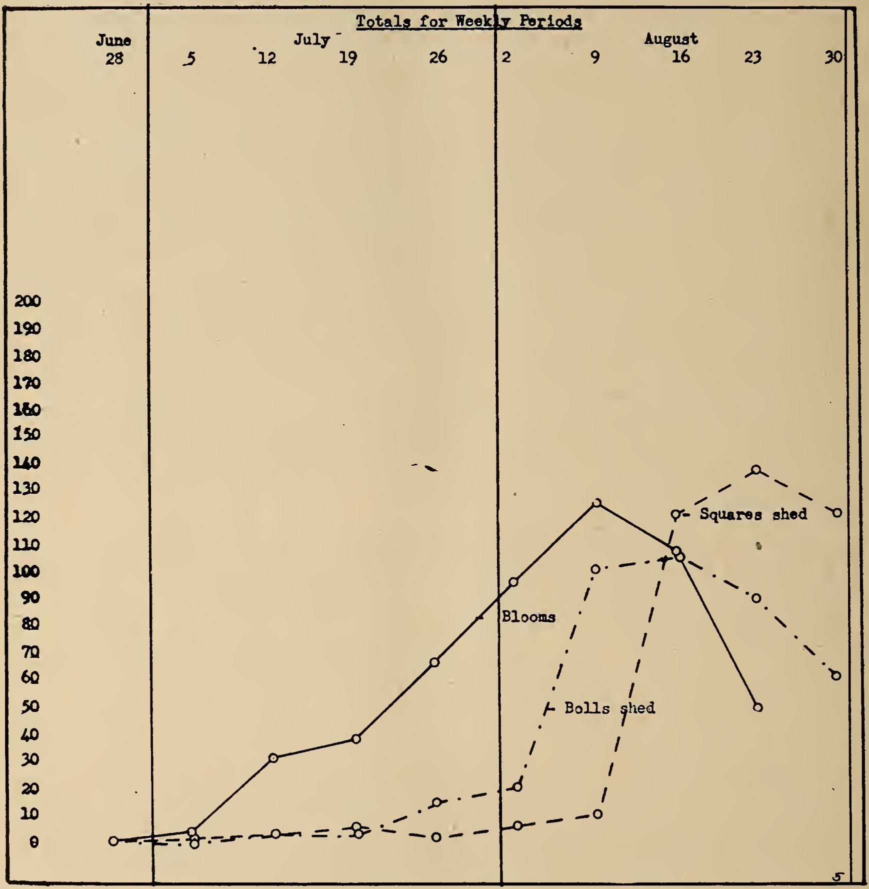


FIGURE 5. Rate of Blooming and Boll and Square Shedding on Unfertilized Plots, 1944.

Figure 6 shows the comparative effect of 50 pounds of nitrogen when used alone as a fertilizer on the type of land being used in the cotton experiment. For this land, nitrogen used alone is an unbalanced fertilizer which does not improve production as compared with the unfertilized plots. In fact the blooming rate is somewhat lower and the square shedding higher than for the unfertilized plots, but the general courses of the curves are much the same.

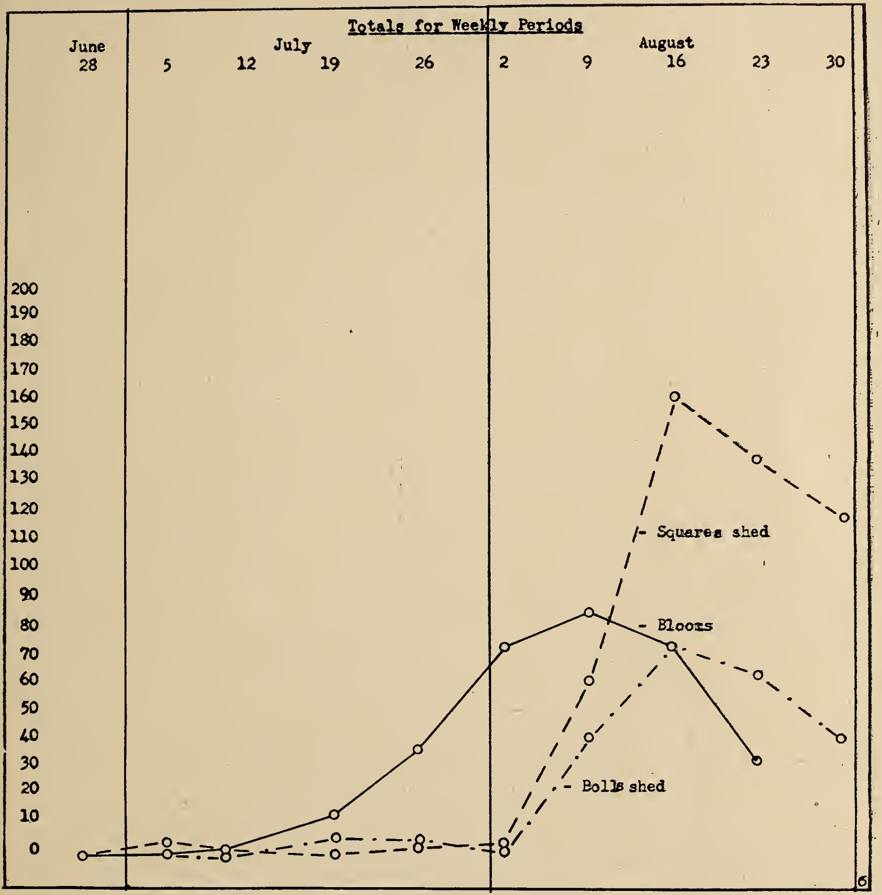


FIGURE 6. Effect of 50 Pounds of Nitrogen on Cotton Blooming and Square and Boll Shedding in 1944.

Figure 7 shows the effect of 40 pounds of potash when used alone as an unbalanced fertilizer. It will be noted that the bloom production is low and shedding rate comparatively high. The blooming rate is slightly lower than for the check and the peak was reached a week later. This probably has some significance since potash usually makes cotton fruiting somewhat later. On the whole, the course of the curves is very similar to the courses followed in Figures 5 and 6.

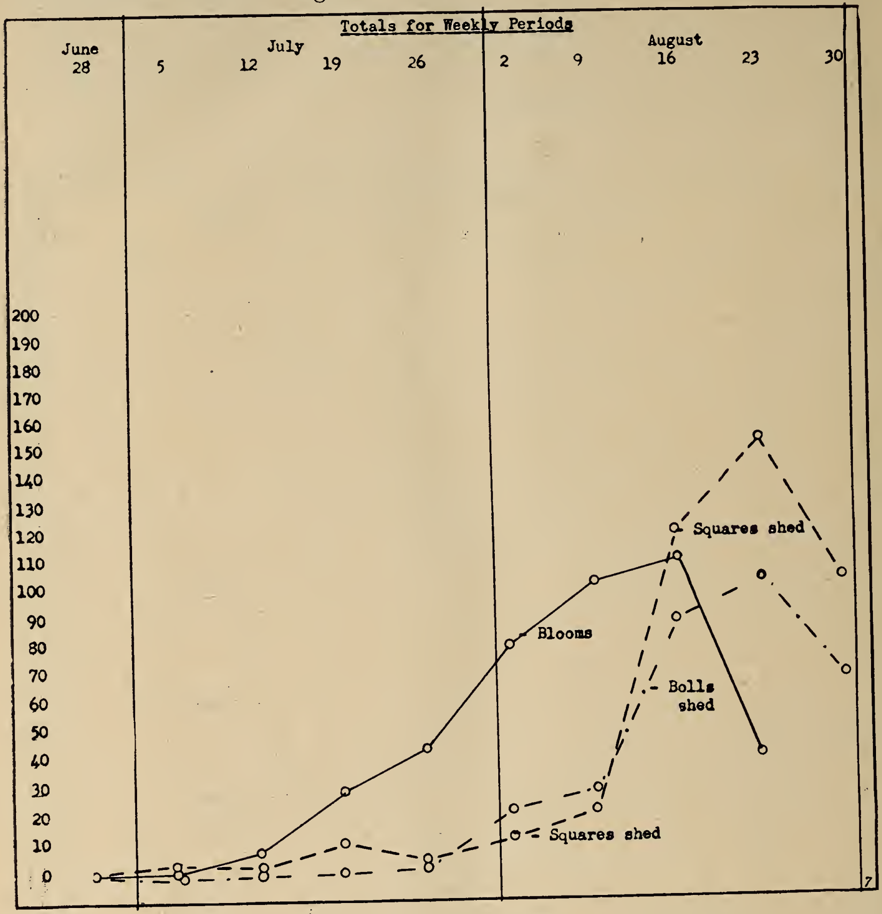


FIGURE 7. Effect of 40 Pounds Potash on Cotton Blooming and Square and Boll Shedding in 1944.

Figure 8 indicates the amount of blooming and boll and square shedding during the season of 1944 on plots that received 100 pounds of phosphoric acid. It will be observed that the blooming rate is much higher than for the check and for the other single-ingredient fertilizers used. This was due to the fact that the low amount of phosphorus already in the soil served as a severe limiting factor to production. When a liberal application of phosphorus was made, this, aided by the limited amount of nitrogen and potash present in the soil, made a fair fertilizer and resulted in increased production. The amount of boll shedding was considerable but the percentage was lower than in the case of the other fertilizers just mentioned. There were many more forms on the plants and they were earlier. The blooming peak was reached during the week of August 2. The square shedding was unusually low, comparatively. Being early, a high percentage of the squares made flowers before the

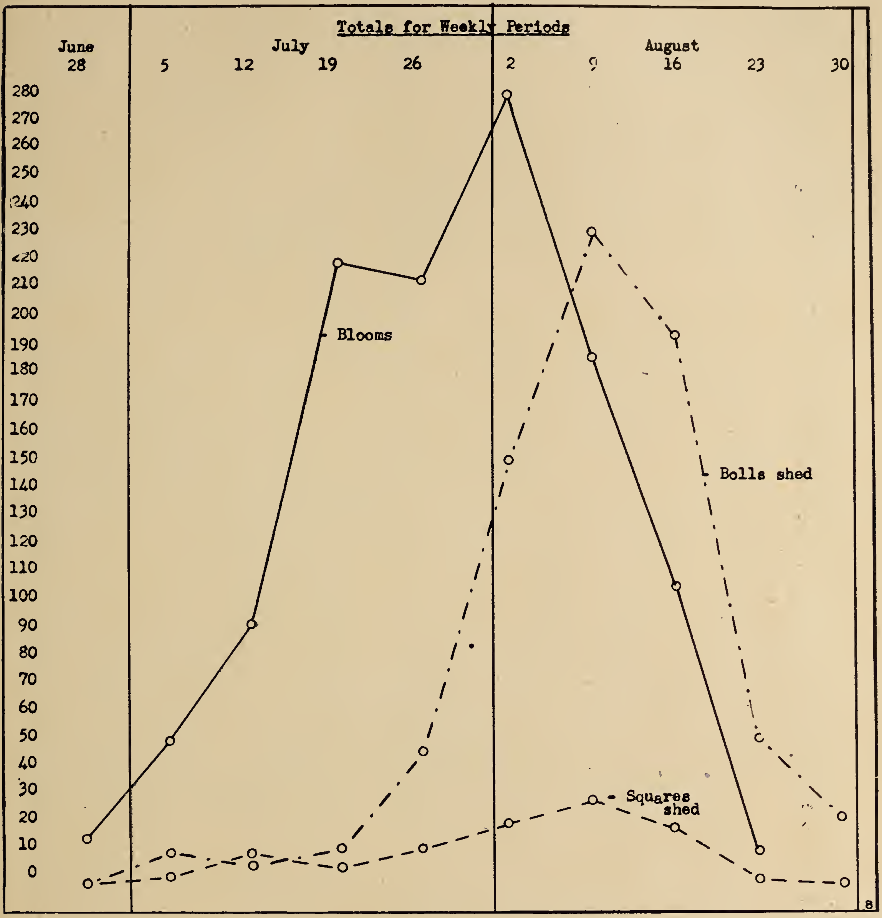


FIGURE 8. Effect of 100 Pounds Phosphoric Acid on Cotton Blooming and Square and Boll Shedding.

boll weevils came around, and, too, there was more nutrient material in the plants to use in developing small squares into blooms.

Figure 9 gives the blooming and shedding rates following the use of 1,000 pounds of a 5-10-4 fertilizer. This being a complete fertilizer and used in liberal quantity, good plant growth and heavy bloom production resulted. With the complete fertilizer the blooming started earlier and reached its peak sooner—during the week of July 26. Blooming practically ceased by the middle of August. Boll shedding became heavy about the 26th of July and continued heavy as long as the plants were

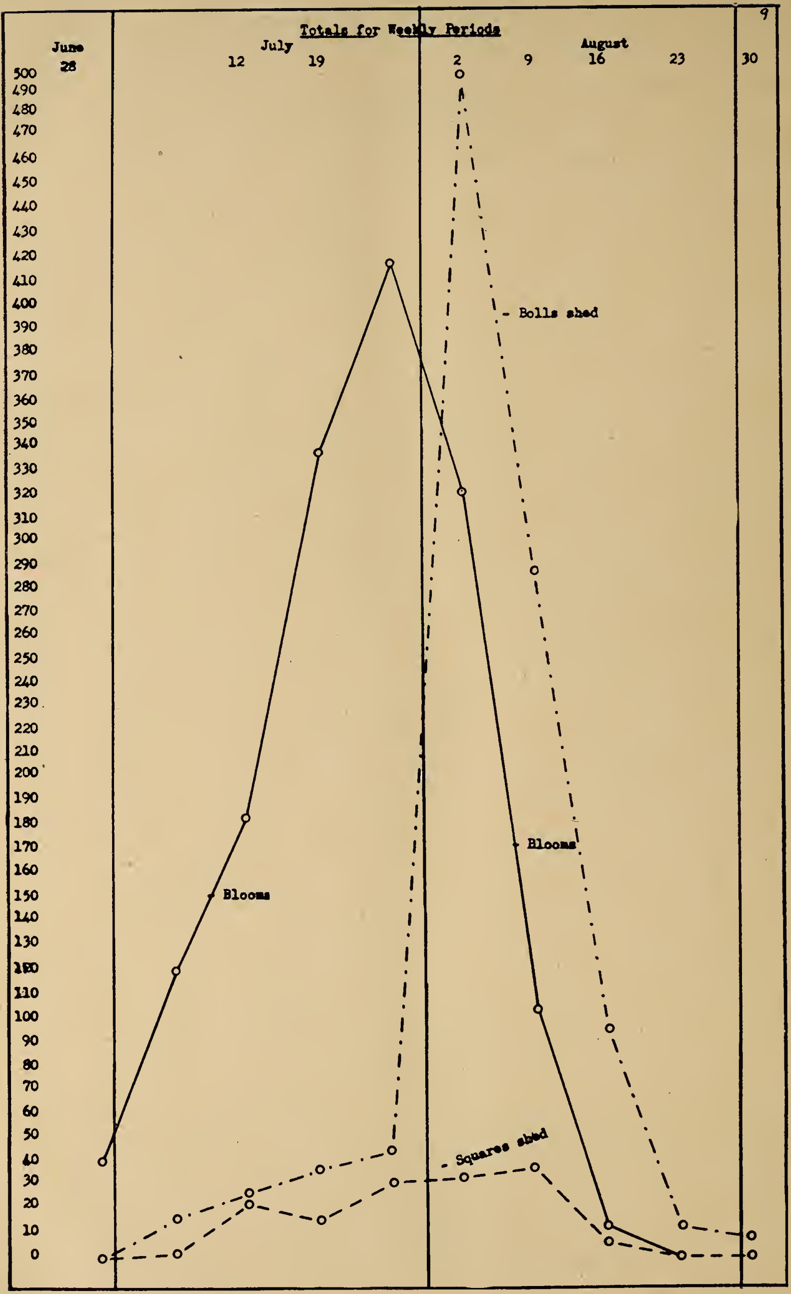


FIGURE 9. Effect of 1,000 Pounds of a 5-10-4 Fertilizer on Cotton Blooming and Shedding in 1944.

blooming freely, but a good crop of bolls was set before shedding became active. Square shedding was light during the entire season and had but little influence on production.

The fruiting following the use of treatment 7 is shown in Figure 10. This treatment was like the one used for Figure 9 except that 20 tons of rotted barn manure were substituted for the 50 pounds of nitrogen. The manure, in addition to supplying the usual fertilizer ingredients, improved the condition of the soil by adding a considerable quantity of organic matter. The curves for this treatment are similar to the ones for the 1,000 pounds of a 5-10-4 fertilizer except that the blooming rate is slightly greater and the boll shedding a little less. The additional organic matter in the soil probably aided in providing a more uniform supply of moisture to the plant roots.

Table 2 totals the blooming on all the experimental plots during the seasons of 1943 and 1944. "Bolls picked" covers all good bolls that opened during the season. As was mentioned previously, poorer soil was used during 1944 and this was reflected in a much poorer blooming rate on the unfertilized or poorly fertilized plots. Where the plots were well-fertilized as is shown in Figure 3, the blooming rate the two years was very similar. The soil difference is further reflected in the percentage of boll set. In 1944 the well fertilized plots set a slightly higher percentage of bolls than did the corresponding plots in 1943, but the poorly fertilized plots in 1944 set a much lower percentage. The yields of seed cotton on the well fertilized plots were high both years, considerably higher than would be had from similar fertilization under field conditions. Here the plots were small, the plants had abundant space, the stands were perfect, and plants were well cultivated. The percentage of diseased and worthless bolls was determined only in 1944. It will be seen that there seems to be a positive correlation between amount of fertilizer used and percentage of good bolls.

TABLE 2. EFFECT OF DIFFERENT FERTILIZER TREATMENTS ON BLOOMING RATE, PERCENTAGE OF BOLL RETENTION, AND COTTON PRODUCTION

	1943				1944				
Treatment	*Number Blooms*	*Number Bolls Picked*	*Percent Boll Set*	*Pounds* Seed Cotton Per Acre*	*Number Blooms*	*Number Bolls Set*	*Percent Boll Set*	*Percent Diseased and Defective Bolls*	*Pounds* Seed Cotton Per Acre*
1. Check—no fertilizer..........	1103	567	51.4	1950	518	199	38.4	18.1	629
2. 1000 lbs. of a 5-10-4 fert.......	1684	938	55.7	3226	1534	888	57.9	7.0	3199
3. 50 lbs. of nitrogen...........	1178	613	52.0	2108	334	123	36.8	32.5	377
4. 100 lbs. of phosphoric acid.....	1327	733	55.2	2444	1185	689	58.1	7.0	2431
5. 40 lbs. of potash.............	1232	663	53.8	2280	425	177	41.6	22.6	558
6. 50 lbs. of nitrogen 100 lbs. of phosphoric acid.....	1381	699	50.6	2404	1307	720	55.1	11.8	2540
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure...........	1662	944	56.8	3246	1657	985	59.4	3.2	3621
8A. 1000 lbs. of a 5-10-4 fert. and extra water...........	1675	980	58.5	3370	1412	846	59.9	8.3	3237
8B. 1000 lbs. of a 5-10-4 fert. and arid conditions.........	1045	522	49.9	1796					

*The yields are based on a count of the number of bolls produced, estimating 100 to a pound of seed cotton. The extra space around the plants increased yields considerably.

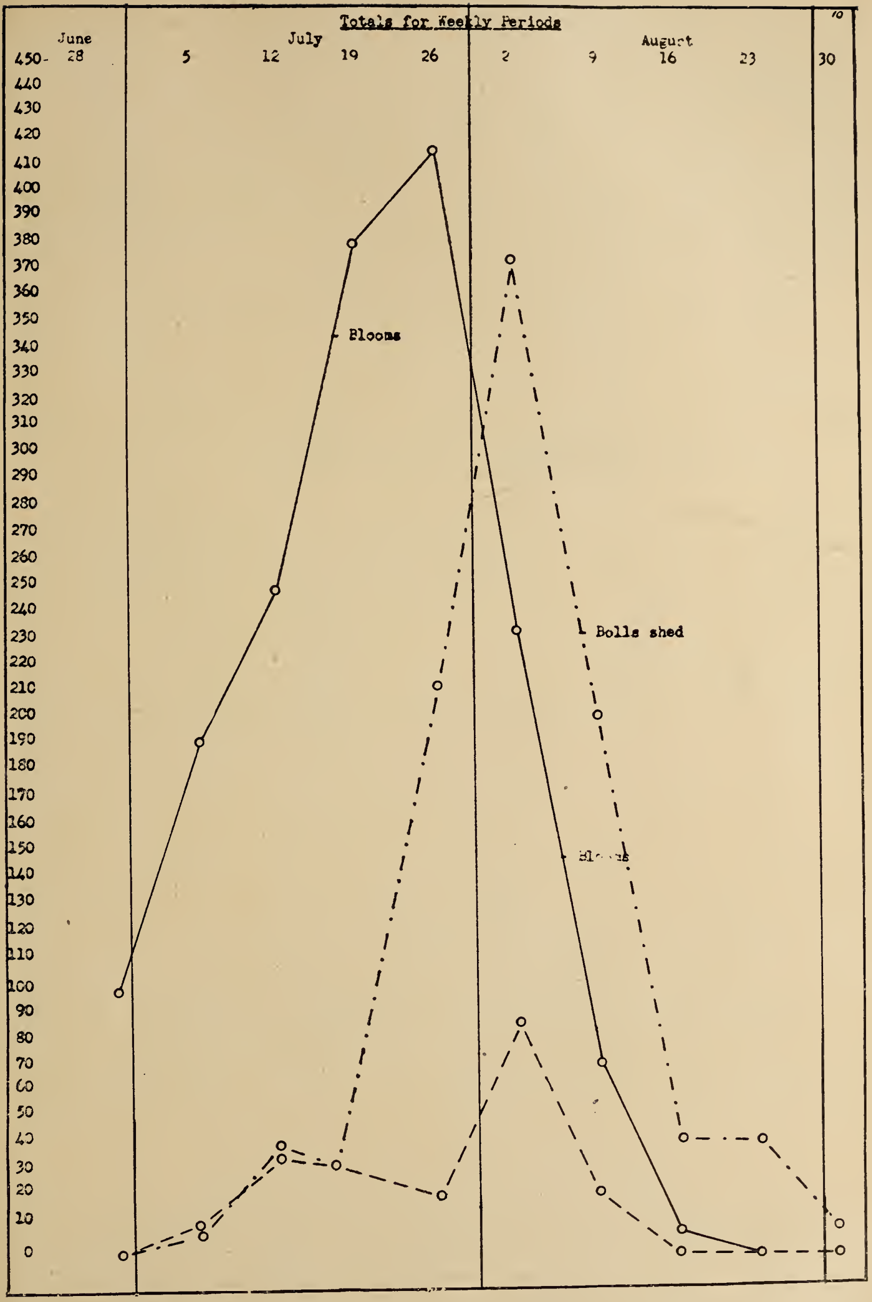


FIGURE 10. Effect of 100 Pounds Phosphoric Acid, 40 Pounds Potash, and 20 Tons Barn Manure on Cotton Fruiting.

Early in the blooming period while the plants are comparatively young and vigorous, the percentage of boll set is much higher than it is later when the nutrient materials in the plants tend to become exhausted. This difference in boll set in different parts of the season is well shown in Table 3. No blooms were tagged either season until the plants had begun to bloom rather freely. The first tagging date was delayed in 1944 to give the small plants on the poorly fertilized plots time to start blooming. On account of this we did not get so many tagged blooms on the larger plants during the fore part of the season and this resulted in a considerably lower percentage of set in the season of 1944 as a whole.

TABLE 3. EFFECT OF POSITION IN BLOOMING PERIOD ON PERCENTAGE OF BOLL SET

1943			1944		
Date Tagged	*No. Blooms Tagged*	*Percent Bolls Set*	*Date Tagged*	*No. Blooms Tagged*	*Percent Bolls Set*
June 29	180	73.9	July 17	280 on all Plants	68.2
June 30	205	85.3	July 18	245 on all Plants	80.0
July 6	300	75.7	July 27	12 on small Plants	58.3
July 7	300	70.7	July 28	263 on all Plants	20.5
July 19	505	24.6	July 29	307 on all Plants	18.6
July 20	335	24.8	July 30	48 on small Plants	45.8
August 2*	100	5.0	August 10	9 on all Plants	11.1
August 3	75	4.0	August 11	112 on all Plants	2.7
			August 12	141 on all Plants	14.9
Average		54.2	Average		38.9

*The bolls set in August were all small and defective.

On July 27 and 30, blooms were tagged on small plants only, while on July 28 and 29 they were tagged on all plants on the plots. It will be seen that the percentage of set was much higher, more than twice as great, on the small plants. They had developed very few bolls during the early part of the season and probably retained more of their vigor.

Effect of Fertilizers on Boll Period

By boll period is meant the length of time from bloom to open boll. This covers the number of days needed for the boll contents to develop and mature. A glance at Table 4 will show that there is a considerable difference in different fertilizers in their effect on the rapidity of boll maturity. The better or complete fertilizers consistently shortened the boll period six to eight days.

TABLE 4. EFFECT OF FERTILIZERS ON BOLL PERIOD

Treatment	*Number Bolls Studied*	*No. Days In Boll Period Weighted Average*
1. Check—no fertilizer	38	51.9
2. 1000 lbs. of a 5-10-4 fertilizer	72	45.0
3. 50 lbs. of nitrogen	26	51.6
4. 100 lbs. of phosphoric acid	84	44.8
5. 40 lbs. of potash	46	50.9
6. 50 lbs. nitrogen 100 lbs. of phosphoric acid	124	43.9
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure	80	44.3

Effect of Fertilizers and Position within the Fruiting Period on Boll Size

It is to be expected that well fertilized plants will make greater growth and have larger, better developed bolls. The weights of the bolls from the different plots grown in 1943 show a steady and consistent increase with the use of more or better fertilizers. This is indicated in

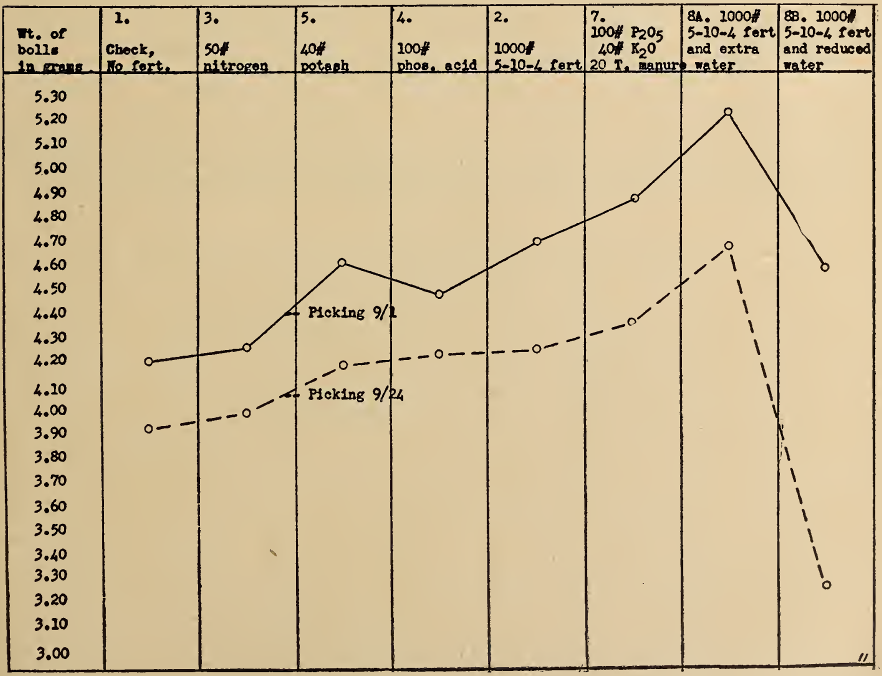


FIGURE 11. Effect of Fertilizers and Position Within the Fruiting Period on Boll Size, 1943.

Figure 11. It will be noted that the manure treatment induced better growth than the 1,000 pounds of a complete fertilizer, but the complete fertilizer with some extra water added, in treatment 8A, did somewhat better than the manure. As was to be expected, where the plants were grown under semi-arid conditions in treatment 8B, the bolls were somewhat smaller.

The second picking, made 23 days after the first and including bolls developed some 20 days later in the fruiting season, had bolls consistently smaller than the bolls from the first picking, but the effect of the fertilizer treatment was relatively much the same. The bolls from treatment 8B dropped way down in size (Figure 11). The sheltering effect made the soil drier later in the season, which lessened the boll size still more. It may be suspected that the difference in weight between the two pickings was due to greener bolls being harvested the first picking. This hardly holds because a good many of the bolls gathered the first picking had been open longer than bolls harvested the second picking, and too, all the material was dried in the laboratory some weeks before weighing.

The results in 1944 (Figure 12) checked fairly well with the results in 1943. There was a gradual upward trend in boll weight with better fertilization, and, in the main, heavier bolls were obtained the first picking. In the case of the check, nitrogen alone, and potash alone, better weights were obtained the second picking than the first. This seems to agree with observations made on other characters during 1944 and can be explained as mentioned previously.

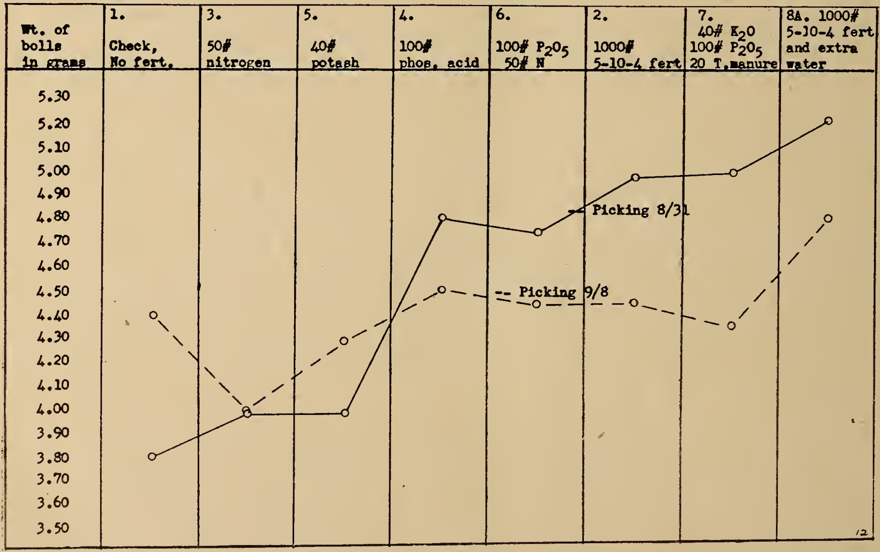


FIGURE 12. Effect of Fertilizers and Position in the Fruiting Period on Boll Size, 1944.

Effect of Fertilizer Treatment and Seasonal Period on the Percentage of Five-Lock Bolls

The percentage of five-lock bolls a strain has is largely a genetic character—some strains having a much higher percentage than others—but the environmental conditions also have considerable effect. This is shown in Figure 13. The well fertilized plants consistently produced a considerably higher percentage of five-lock bolls than the poorly fertilized, both in 1943 and 1944, the extreme range of difference both years being more than 30 per cent.

Some study was made also of the relative percentage of five-lock bolls developed during different parts of the season, both in 1943 and 1944. The percentage was not definitely high during any part of the season, nor low in any part.

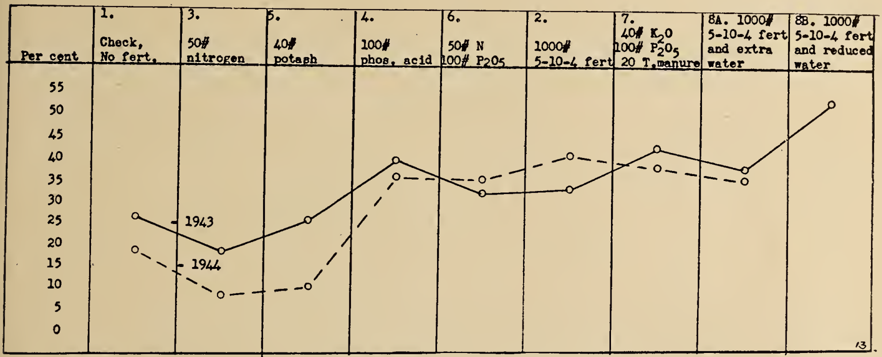


FIGURE 13. Relation of Fertilizers Used and the Percentage of Five-Lock Bolls in 1943 and 1944.

Effect of Certain Fertilizers on the Weight of Four- and Five-Lock Bolls

The graph shown in Figure 14 is based on the mean weight of four- and five-lock bolls from four series and three pickings. The results in 1943 (Figure 14) are very consistent, agreeing closely with measurements of other characters that year. There is a steady upward climb in boll size with the use of better fertilization, reaching the peak with 1,000 pounds of a 5-10-4 fertilizer and irrigation. The 8B treatment again produced smaller bolls than several other treatments because of lack of moisture. For all the treatments, the four-lock bolls weighed less than the five-lock.

The results for 1944 are not so consistent. They show greater weights for the five-lock bolls in most cases, but there is not much increase in weight following better fertilization. This was probably largely due to seasonal effect. As has been explained elsewhere, the first bolls that a cotton plant develops tend to be heavier than ones produced later. The plants with poorer fertilization tend to be smaller and later in fruiting.

When they were producing their first bolls, the larger plants were producing a second crop, which averaged somewhat lighter than the first crop. The soil used in 1944 being naturally less fertile than the soil used in 1943, the contrasts between plots were greater in 1944, and the seasonal effects also.

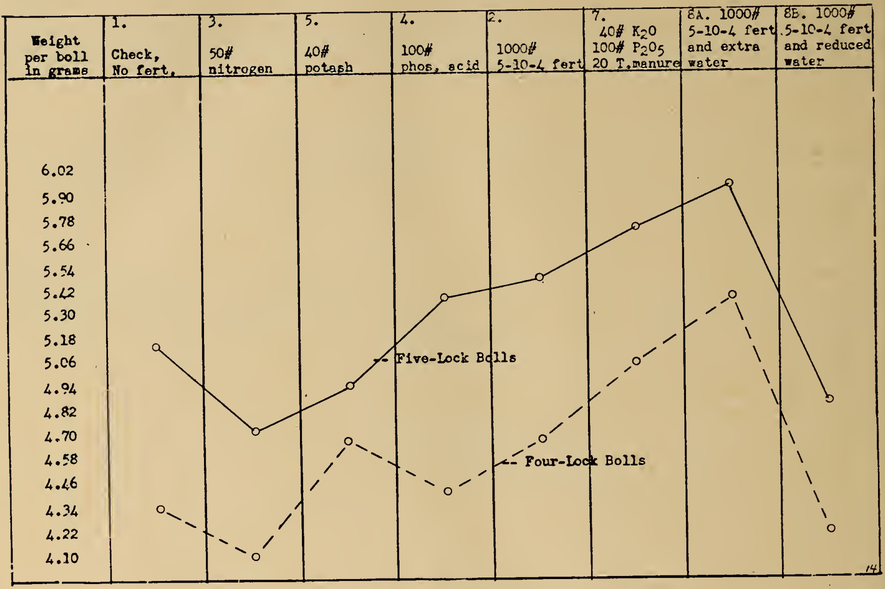


FIGURE 14. Effect of Certain Fertilizers on the Weight of Four- and Five-Lock Dated Bolls, 1943.

Effect of Fertilizers on the Number of Seeds in Locks of Four- and Five-Lock Bolls

The accompanying graph (Figure 15) is based on the means of counts of seeds in locks obtained from four replicates at three different picking dates in 1943. Dated bolls were used.

The results are about according to expectation—four-lock bolls having more seed per lock than five-lock, and the number of seeds per lock increasing as the fertilizers get better. With the poorer fertilizers there were more rudimentary seeds that failed to develop. These were not counted. The lack of moisture in treatment 8B apparently reduced the number of seeds sharply for the four-lock bolls but had no effect on the number in the five-lock bolls.

Similar counts of the number of seeds in four- and five-lock bolls were made in 1944. The general trend was the same the two years but with more irregularities in 1944. This was doubtless due to greater contrasts in the growth of the plants that year. Some studies were made also of the relative number of seeds produced per lock during different parts of the fruiting season but no consistent differences could be observed either year.

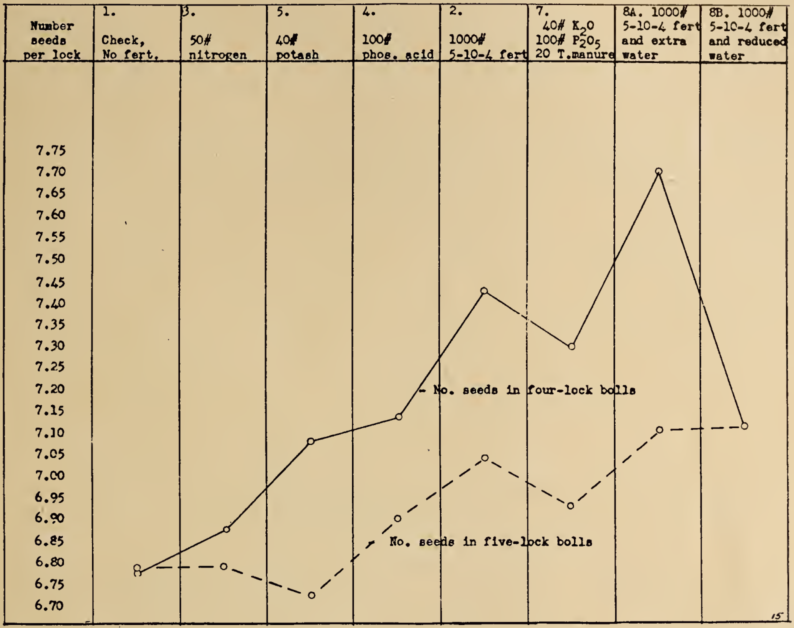


FIGURE 15. Effect of Certain Fertilizers on the Number of Seed in Locks of Four- and Five-Lock Dated Bolls, 1943.

Effect of Fertilizers on Seed Index

By seed index is meant the weight of 100 representative seeds. This weight is usually expressed in grams. In Table 5 may be seen the mean weights for one picking in 1943 and for three in 1944. The one picking made in 1943 was made at relatively the same time in the season as the first in 1944 and the weights correspond rather closely. The better fertilized plants consistently produced heavier seed than the poorly fertilized at the first picking, but later in the season their seeds became smaller, while those from the poorly fertilized plants tended to become heavier. This, however, is in line with changes in several other characters studied. The added vigor picked up by the more poorly fertilized plants as the season progressed is reflected in the size of the seed produced. The better fertilized plants produced not only more bolls but heavier ones, more five-lock bolls, and more seed per lock. These facts also help to explain the reason for smaller seeds on the better fertilized plants the latter part of the fruiting season.

TABLE 5. SEED INDEX FROM MASSED BOLLS — 1943 AND 1944

Treatment	1943	1944			*Mean* *for* 1944 *Dates*
	Picked 9/1/43	*Picked* 8/31/44	*Picked* 9/8/44	*Picked* 9/26/44	
1. Check—no fertilizer	8.72	9.22	9.80	10.09	9.71
2. 1000 lbs. of a 5-10-4 fertilizer	9.81	9.62	9.30	8.75	9.22
3. 50 lbs. of nitrogen	9.14	9.14	9.84	10.31	9.76
4. 100 lbs. of phosphoric acid	10.16	9.87	9.43	9.27	9.52
5. 40 lbs. of potash	9.59	9.64	9.83	10.41	9.96
6. 50 lbs. of nitrogen 100 lbs. of phosphoric acid		9.72	9.39	9.81	9.62
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure	10.98	9.64	9.30	9.11	9.35
8A. 1000 lbs. of a 5-10-4 fertilizer and extra water	10.60	10.41	9.86	9.40	9.89

Effect of Fertilizers on Oil and Ammonia Content of Cotton Seed

It has been known in a general way for some years that better or more fertile soils tend to produce cotton plants with larger and better developed seeds which contain a higher percentage of oil, but it has not been so well understood just what effect particular fertilizer elements or ingredients have on oil content. It was thought the setup of this experiment was such that it would give some information on the particular effect of certain fertilizers, so seed samples from the various plots on different picking dates were sent to Dr. Tharp of the University of Arkansas for study and analysis. A large number of analyses were made, the details of which will be published elsewhere. Results show that, aside from the effect of potash on oil content and nitrogen on ammonia content, the effects of the specific fertilizer ingredients used were not significant. An increase in potash application increased the oil content in all cases, and an increase in the amount of nitrogen alone applied gave an increase in the percentage of ammonia in the seeds but the percentage of oil was lower. The use of nitrogen alone made an unbalanced fertilizer that resulted in poor yields.

Figure 16 shows the general effect of the different treatments for the season of 1943. It will be noted that the better and well balanced fertilizers consistently produced seed with higher oil content, except in the case of treatment 8B, where the supply of moisture was deficient. It will be observed, too, that in general an increase in oil percentage is associated with a lowering in percentage of ammonia.

Table 6. Oil and Ammonia Contents of Cotton Seed Kernels as Affected by Different Fertilizer Treatments—1943

Treatment	*Percent of Oil*				*Percent of Ammonia*			
	Mean % for Bolls Tagged			*Mean % for Season*	*Mean % for Bolls Tagged*			*Mean % for Season*
	6/30	7/7	7/20		6/30	7/7	7/20	
1. Check—no fertilizer	33.18	32.32	29.88	31.79	7.95	7.97	8.30	8.07
2. 1000 lbs. of a 5-10-4 fertilizer	33.99	33.03	31.76	32.93	7.73	7.77	8.04	7.85
3. 50 lbs of nitrogen	31.56	31.03	29.80	30.79	8.42	8.34	8.40	8.39
4. 100 lbs. of phosphoric acid	35.05	33.00	29.89	32.64	7.38	7.76	8.17	7.77
5. 40 lbs. of potash	33.44	33.34	33.00	33.26	7.89	7.80	7.85	7.85
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure	34.30	34.93	29.59	32.94	7.23	7.15	8.18	7.52
8A. 1000 lbs. of a 5-10-4 fertilizer and extra water	32.85	32.96	32.59	32.80	7.73	7.46	8.03	7.74
8B. 1000 lbs. of a 5-10-4 fertilizer and reduced moisture	31.67	33.09	29.66	31.44	8.11	7.89	8.26	8.09
Grand Means	33.26	32.96	30.77		7.81	7.77	8.15	

Table 6 shows the means for the oil and ammonia percentages for different tagging dates during the season of 1943 and for the various treatments during the season as a whole. These figures present the data on which Figure 16 is based, and of course the thought presented is the same.

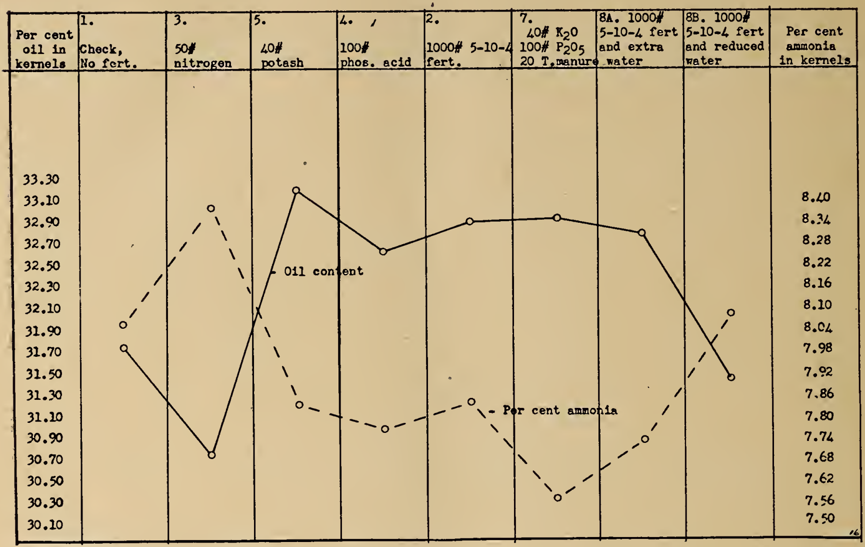


FIGURE 16. Effect of Fertilizers on the Oil and Ammonia Content of Cotton Seed Kernels. (Based on Means of Seed Analyses for Three Different Dates During Season of 1943.)

Figure 16A indicates relative oil content in cotton seed kernels from bolls produced at different periods during the fruiting season of 1943. Although the results are not consistent in a few instances, it appears in general that as the fruiting season progresses, the percentage of oil in the kernels tends to become lower. The grand mean for the first tagging date was 2.49 per cent higher than the mean for the last date, which was August 20.

The relative percentage of ammonia or protein in the seed kernels, on the other hand, increased as the season advanced; the general mean for the kernels from the first tagging date was 7.81 per cent, while the mean for the last tagging date was 8.15 per cent. Figure 17 shows graphically the difference in percentage of ammonia produced at two different periods during the season of 1943. While the difference shown here is not great, it is consistent.

Effect of Treatments on Lint Index

By lint index is meant the weight of the lint on 100 seeds. The weight is measured in grams. The lint index is a better measure of lint production than lint percentage because lint percentage is determined to a considerable degree by the size of the seed and their weight.

Table 7 shows the comparative lint index of cotton from plots receiving different fertilizer treatments during the seasons of 1943 and 1944. In 1944 determinations were made for three different picking dates. It may be seen that in 1943 the better fertilized plots consistently produced cotton with a higher lint index than the unfertilized or poorly fertilized ones. The difference is not so great (about 16 per cent on the average), but is enough to be of considerable consequence in a valuable product like cotton lint.

TABLE 7. LINT INDEX FROM MASSED BOLLS—1943 AND 1944

	1943	1944			Mean for 1944 season
	Picked	*Picked*			
Treatment	9/1	8/31	9/8	9/26	
1. Check—no fertilizer	5.08	5.33	5.59	5.36	5.43
2. 1000 lbs. of a 5-10-4 fertilizer	5.81	5.55	5.64	4.58	5.26
3. 50 lbs. of nitrogen	5.08	5.12	5.57	5.76	5.48
4. 100 lbs. of phosphoric acid	5.93	5.96	5.54	4.86	5.45
5. 40 lbs. of potash	5.47	5.52	5.66	5.45	5.54
6. 50 lbs. of nitrogen 100 lbs. of phosphoric acid	....	5.86	5.15	5.53	5.51
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure	6.28	5.72	5.69	5.06	5.49
8A. 1000 lbs. of a 5-10-4 fertilizer and extra water	6.12	5.98	5.84	5.03	5.62
8B. 1000 lbs. of a 5-10-4 fertilizer and reduced moisture	6.01	....	....	....	....

In 1944 the first picking made on August 31 gave cotton with lint indices for the different treatments similar to those of 1943. Later pickings in 1944, though, showed a rise in the index for the poorer fertilizers and a lowering for the better. This is in line with observations made on other characters of the plant, as blooming rate, boll size, etc., and is doubtless affected by the same influences as pointed out previously.

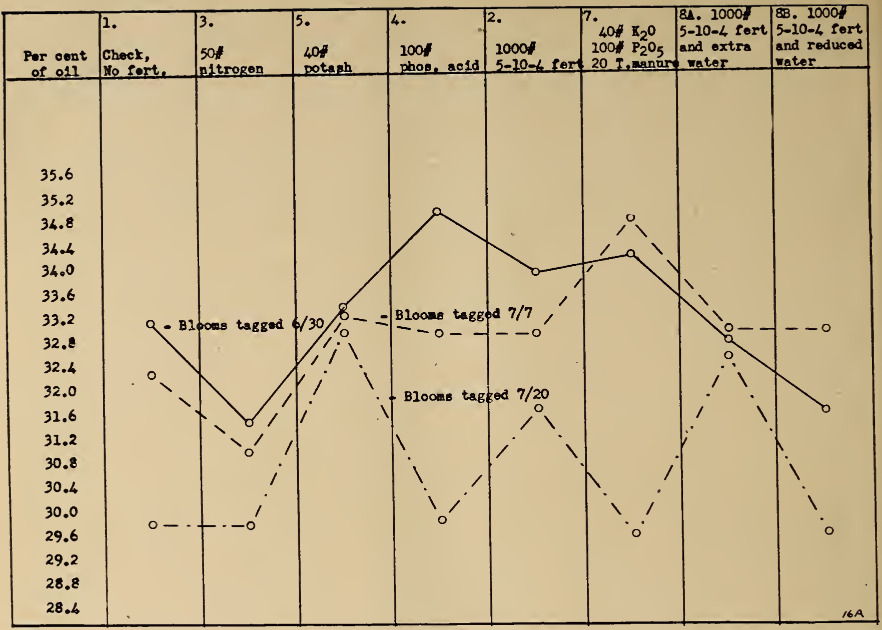


FIGURE 16A. Oil Content of Cotton Seed Kernels at Different Periods During the Season of 1943.

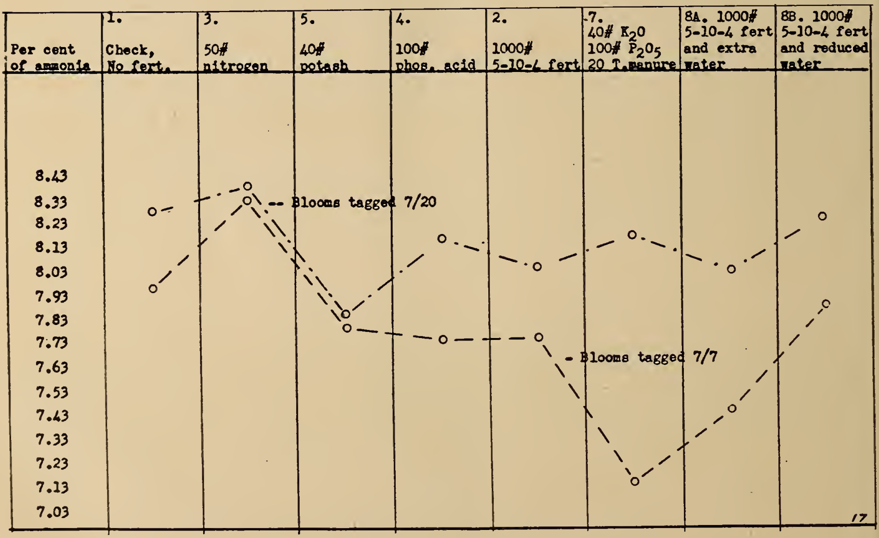


FIGURE 17. Ammonia Content of Cotton Seed Kernels at Different Periods During the Season of 1943.

Effect of Treatments on Lint Percentage

The lint percentage figures for 1943 and 1944, given in Table 8, show a trend in favor of the better fertilizers. The difference is not great (1 to 2 per cent as a rule) but is fairly consistent. The means for 1944 agree closely with the one-picking figures for 1943. Samples from the last picking date in 1944 show a considerably lower percentage than samples from the second picking date, the mean difference for all the treatments being 2 per cent.

TABLE 8. LINT PERCENTAGE FROM MASSED BOLLS—1943 AND 1944

Treatment	1943	1944			*Mean for* 1944 *Dates*
	Picked	*Picked*			
	9/1	8/31	9/8	9/26	
1. Check — no fertilizer	36.8	35.8	35.9	34.6	35.4
2. 1000 lbs. of a 5-10-4 fertilizer	37.2	37.7	38.1	35.2	37.0
3. 50 lbs. of nitrogen	35.7	34.4	36.6	35.7	35.6
4. 100 lbs. of phosphoric acid	36.9	37.5	37.2	34.2	36.3
5. 40 lbs. of potash	36.3	36.3	36.9	34.4	35.9
6. 50 lbs. of nitrogen 100 lbs. of phosphoric acid	37.6	37.8	36.9	36.2	37.0
7. 100 lbs. of phosphoric acid 40 lbs. of potash 20 tons of manure	36.3	37.1	38.0	35.7	36.9
8A. 1000 lbs. of a 5-10-4 fertilizer and extra water	36.6	36.5	37.7	35.2	36.5
8B. 1000 lbs. of a 5-10-4 fertilizer and reduced moisture	36.6	....	....	....	....
Average	36.7	36.4	37.2	35.2	....

Effect of Treatment and Seasonal Period on Staple Length

Figure 18 shows the effect that some of the better fertilizers had on mean staple length. Lengths at three different seasonal periods during the season of 1943 are represented. Each number is the mean of eight determinations made with Hertel's* fibrograph machine. The length is shown in thirty-seconds of an inch, and the treatments were treatments 2, 4, 6, 7, and 8A, which were explained previously.

Treatment 8A gave the best staple length on the first date and during the entire season. The staple resulting from blooms tagged on June 30 was slightly more than 31/32 inch in length. This was about 3/32 longer than the staple from treatment 4 and about 5/32 inch longer than the length from treatment 5 shown in Figure 19. The general trend as the season progressed was downward, indicating shorter staple from all the treatments. For treatment 8A the downward course was fairly regular and at the last date the length was about 3/32 inch shorter than the first.

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* All fiber length measurements given in this publication were made in the Knoxville, Tenn., fiber laboratory with Hertel's fibrograph machine.

Treatment 7 also followed a regular downward course, but the other three treatments shown in Figure 18 followed a slightly different course. The second date shows a slightly longer staple than the first for these. It is possible that the plants receiving these treatments picked up some added vigor for a short period after blooming started, which resulted in slightly longer staple from bolls initiated about July 7.

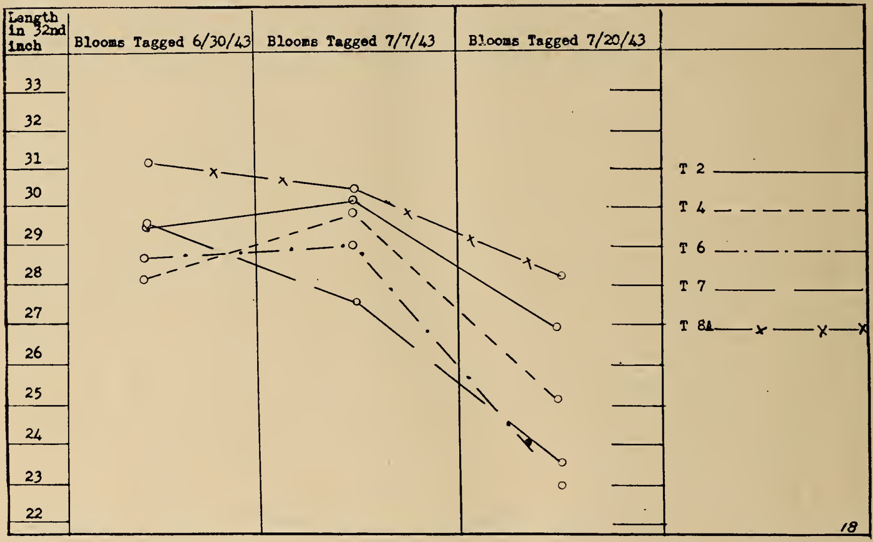

FIGURE 18. Mean Staple Length for Different Dates During Season of 1943.

Figure 19 shows seasonal mean staple length for plants that received no or poor fertilizer treatment in 1943, the treatments being 1, 3, and 5, with treatment 2, one of the better treatments, being used for comparison. It will be noticed that the spread between results from different treatments is considerable, being about 1/32 inch for each period, and 3/32 to 4/32 between the best treatment and the poorest. The staple from three of these treatments increased in length about 1/32 of an inch between the first and second periods, but for treatment 3 there was practically no change. Between the second and third periods there was a shortening of all from 3/32 to 4/32 inch, and the general trend for the season was downward.

Figures 20 and 21, based on work in 1943, represent the upper half mean of fiber length following the different treatments. These length determinations were made with Hertel's fibrograph machine and they correspond rather closely with the staple length given cotton by commercial classers. Here, as is to be expected perhaps, the relative position of the various treatment curves is the same as in Figures 18 and 19, and the seasonal course is much the same. Of the better treatments, treatment 8A ranks highest by a fair margin in both cases, and treatment 3 ranks lowest among the poor fertilizers.

A difference of 1.9/32 inch is required for significance at the 5 per cent level.

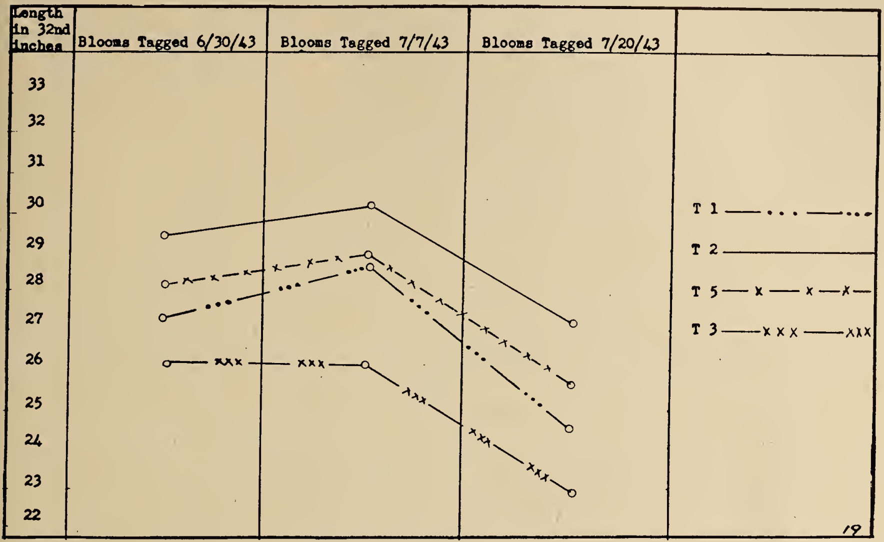

Figure 19. Mean Staple Length for Different Dates During Season of 1943.

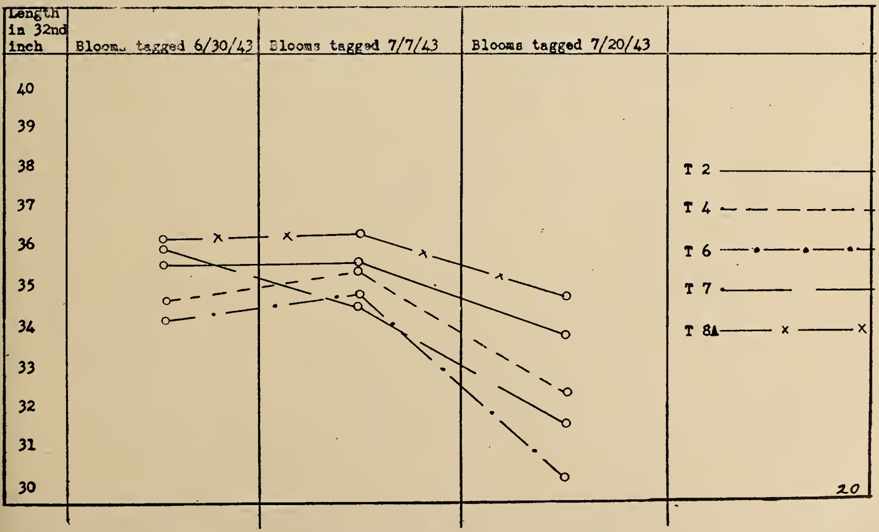

Figure 20. Staple Length of Upper Half Mean for Different Dates During Season of 1943.

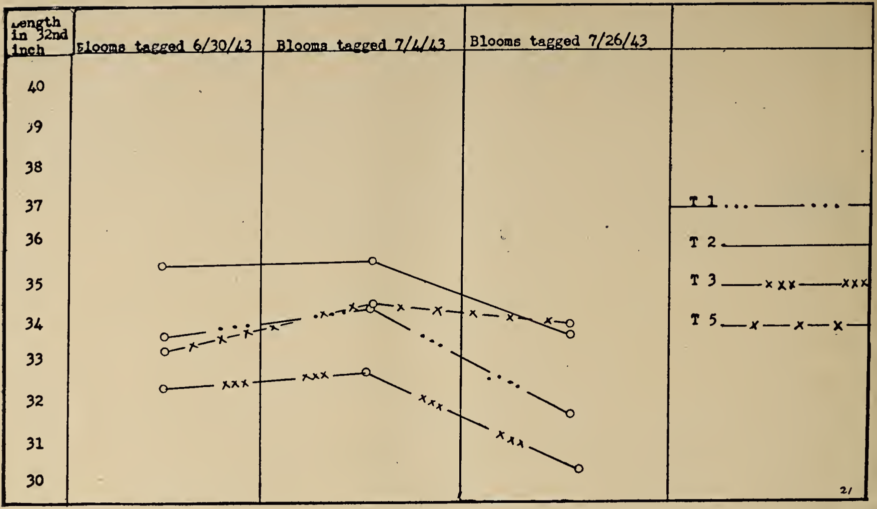

FIGURE 21. Staple Length of Upper Half Mean for Different Dates During Season of 1943.

Figure 22 shows the mean staple length resulting from the use of the better fertilizers during the year of 1944. The work in 1944 was carried on much the same as in 1943 except that instead of using cotton from bolls dated the date the flower opened bolls were picked and massed at four different times during the season. This gave results similar to 1943. The open bolls on any one of the dates all came from flowers that opened near the same time. Within the better treatments the difference in length between individual treatments was not as great as in 1943, but the seasonal drop in length was more regular and greater, being about 6/32 inches for the season. A longer period of time was covered in 1944, however. As in 1943 the cotton with treatment 8A had the longest staple.

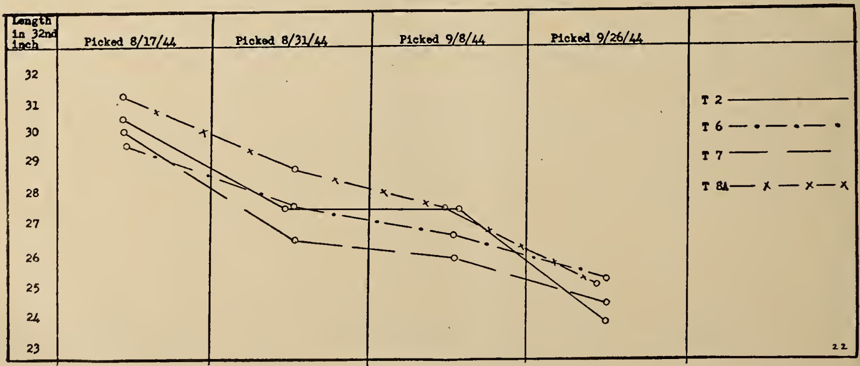

FIGURE 22. Mean Staple Length for Different Dates During Season of 1944.

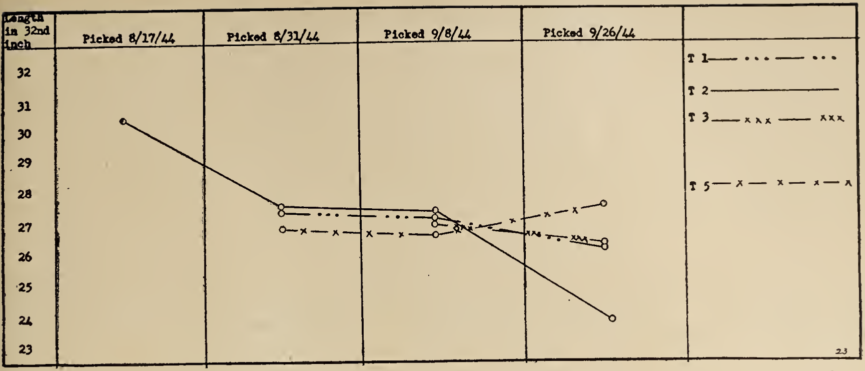

Figure 23. Mean Staple Length for Different Dates During Season of 1944.

The cotton receiving the poorer treatments in 1944 (Figure 23) had no open bolls on the first picking date (August 17) and treatment 3 had no open bolls on August 31. The cotton receiving treatments 1, 3, and 5 made no significant change in mean staple length during the season, and the spread between different treatments was not great. The land was naturally poor and the unbalanced fertilizers, such as the single-element fertilizers used in treatments 3 and 5, gave practically no aid to the plants. They made slow growth and fruited slowly during the season. At the end of the period, they were as vigorous as at any time during the season.

The upper half mean staple length as affected by the better treatments during the season of 1944 is shown in Figure 24. The spread and course of the curves are much the same as for the mean staple length which was just discussed. The lengths for the upper half mean are of course greater than for the mean, but the seasonal drop is somewhat less, being about 4/32 inch.

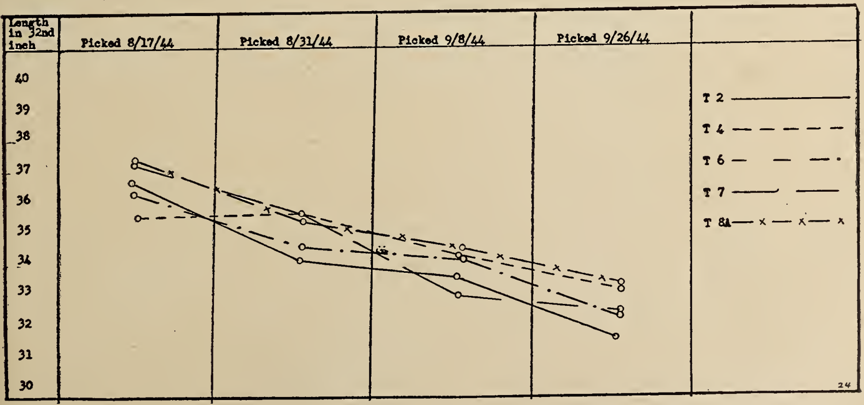

Figure 24. Staple Length of Upper Half Mean for Different Dates During Season of 1944.

The upper half mean staple length as affected by the poorer fertilizer treatments during the season of 1944 is indicated in Figure 25. Here the curves, with the exception of the one representing treatment 2, put in for comparison, are near together and make a slight climb, indicating some increase in staple length as the season progressed. This is in harmony with the growth and changes in other characters of these plants. As the season progressed the plant roots spread farther and the plants attained more vigor.

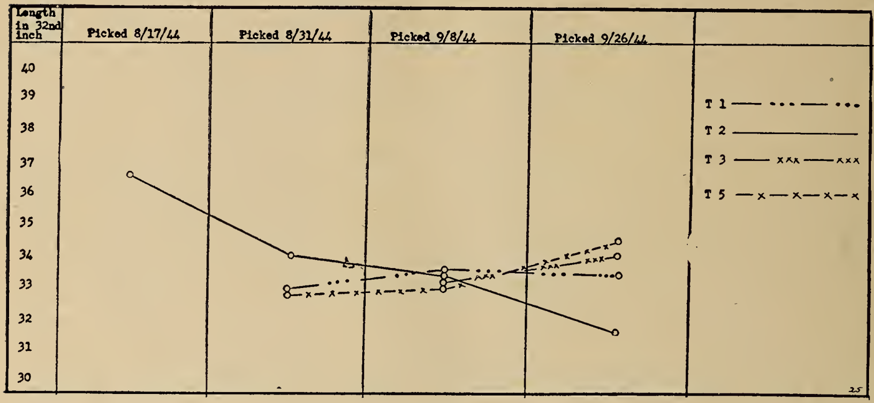

FIGURE 25. Staple Length of Upper Half Mean for Different Dates During Season of 1944.

Fineness of Staple as Affected by Fertilizers Used and Date of Boll Development

The graphs shown in Figure 26 are based on data obtained in several hundred measurements with Hertel's arealometer. With this machine the relative number of fiber surface units (CM^2/mg) in a given weight of cotton may be determined. The finer the fibers are, the more surface they have in proportion to their bulk, and hence the surface area is registered in larger numbers. The larger the number obtained, the finer the fiber.

From the data obtained it appears that there is no definite correlation between the fiber fineness and the treatments used, but there is a definite and very consistent relation between date of boll development and fiber fineness. As the fruiting season progressed, the fibers became finer, but this fineness was probably largely due to a higher percentage of immature or undeveloped fibers in the later bolls. Similar fiber fineness studies were made on the fiber from massed bolls picked from the plots in 1943 and also in 1944, with results somewhat less consistent but similar in the main. In nearly every instance the later bolls had finer fibers.

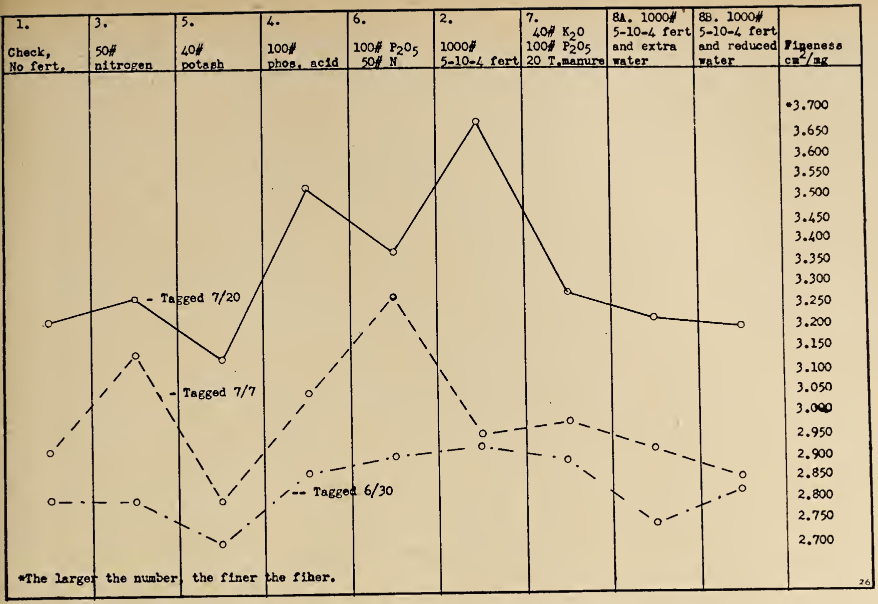

Figure 26. Effect of Treatments and Seasonal Period on the Fineness of Cotton Fibers. Bolls Tagged in 1943.

Effect of Treatments and Seasonal Period on the Strength of Cotton Fibers. Dated Bolls—1943

The fiber strength indicated by the graphs in Figure 27 was determined by testing samples from the various plots with the Pressley strength testing machine, sixteen tests being made for each treatment for each blooming date, with the exception of treatments 8A and 8B, which had only eight tests each. The staple from bolls coming from blooms that opened on June 30 had better strength in all instances where the boll came from plots receiving the better fertilizers. (See treatments 2, 7, 8A, and 8B, Figure 27.) The strength differences resulting from the use of the poorer treatments as in 1, 3, 4, and 5 were 20 to 30 units lower. Bolls initiated by July 20 blooms invariably had weaker fibers than the earlier bolls (Figure 27), but with this date there did not seem to be any consistent difference in the effect of the better fertilizers.

A study was made also in 1943 of the strength of fiber from massed bolls gathered from the variously treated plots on two different picking dates. The different treatments appeared to have no significant effect (Figure 28), but there was a seasonal effect. The fibers from the earlier bolls were invariably stronger. Where massed bolls were used, the development period had a considerably wider range than where dated bolls were used. This allowed seasonal effect to enter. The difference in

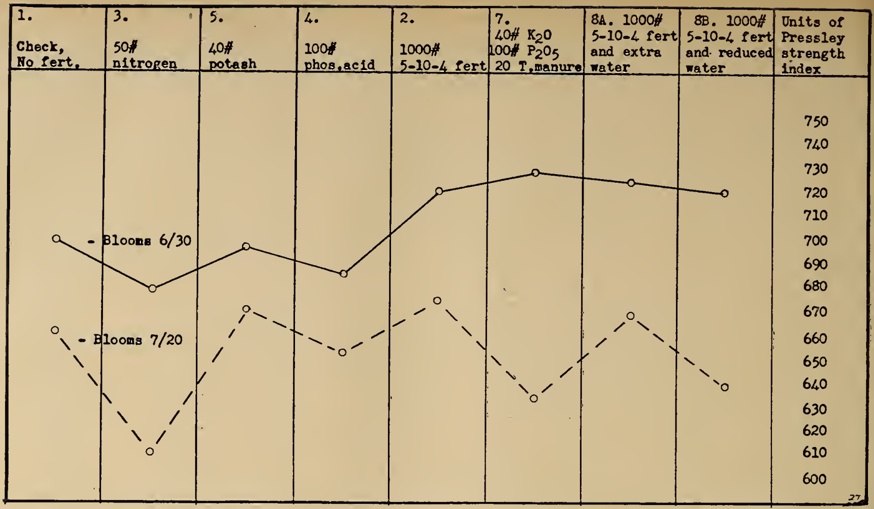

Figure 27. Effect of Treatments and Seasonal Period on Strength of Cotton Fibers. Dated Bolls Grown, 1943.

strength of fiber from different dates probably largely obscured the effect of treatment.

When sacking the lint samples to send to the fiber laboratory for analysis, some study was made of the "feel" of the samples from different pickings and treatments. It was observed that the cotton from the first

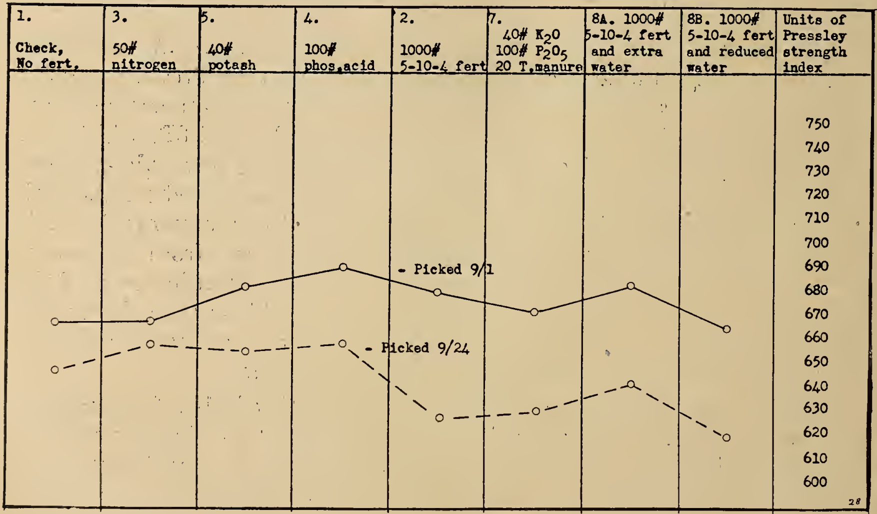

Figure 28. Effect of Treatments and Seasonal Period on Strength of Cotton Fibers from Massed Bolls, 1943.

picking was considerably more springy or resilient when pressed than the cotton from the last picking. The lint from the last picking seemed to be softer and weaker. It also appeared that cotton from well fertilized plots was stronger and more resilient than the cotton from the poorly fertilized plots. These observations were checked by three different observers, who did not know the source of the samples.

Fiber strength studies similar to those in 1943 were made in 1944, but results were different, as may be seen from Figure 29. In 1944 there seemed to be no consistent difference in the effect of the fertilizers used and no difference in different picking dates. As has been explained previously, the land used in 1944 was uniform but very poor and the cotton on the poorly fertilized plots made slow growth and was late in blooming. By the time that these plants were blooming fairly freely, the plants on the better fertilized plots were well along in their blooming period and had passed their prime in vigor. Thus, blooms opening on any particular day were on declining plants if from the well fertilized plots and on plants still in the vigor of youth if from the poorly fertilized plots. Fiber from these two types of plants had similar strength, and when dated bolls or massed bolls were compared, no distinct differences appeared.

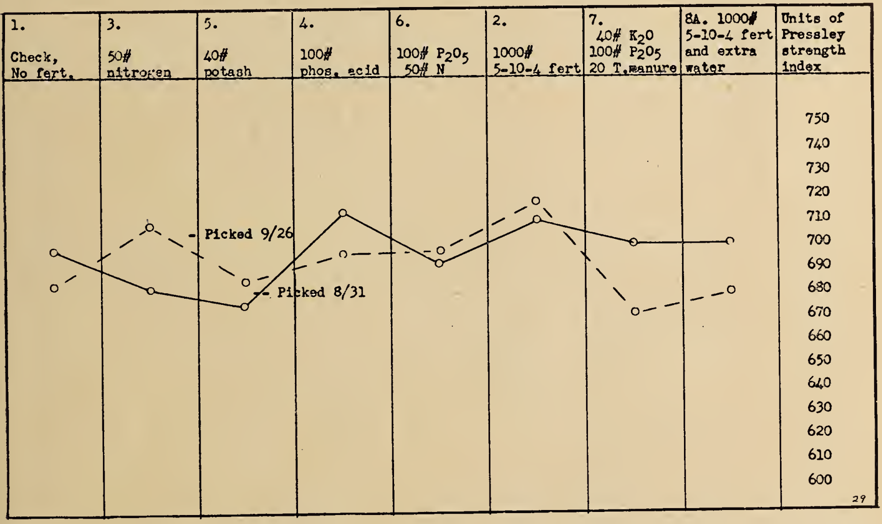

FIGURE 29. Effect of Treatments and Seasonal Period on Strength of Cotton Fibers from Massed Bolls, 1944.

Relation of Strength and Fineness of Fiber

In general, cottons with fine fibers, such as Sea Island, Egyptian, and upland long staple, have stronger fibers, considering their weight per inch, than the coarser-fibered, short-staple cottons, and when spun make stronger yarns. This of course refers to mature or well developed fibers.

In our studies of the relation between fiber fineness as determined by Hertel's arealometer and fiber strength there seemed to be no definite correlation. (See Figure 30.) The curves in the figure are based on the means of measurements of samples from all the different plots on three different tagging dates during the season of 1943. The strength curve shows some upward swing from the use of the better fertilizers (treatments 2, 7, 8A and 8B), but the fineness curve, which is somewhat irregular, does not show any very definite course. It might be considered that treatments 5, 8A and 8B tend toward the production of coarser fiber, which is weaker, but the correlation is not well defined.

As was mentioned previously, fineness measurements made with the Hertel machine do not distinguish between small, immature fibers and small, mature ones. Hence the finer fibers indicated by the machine are not necessarily stronger. The fibers of any one given lot of cotton may be weaker due to immaturity and thinner walls.

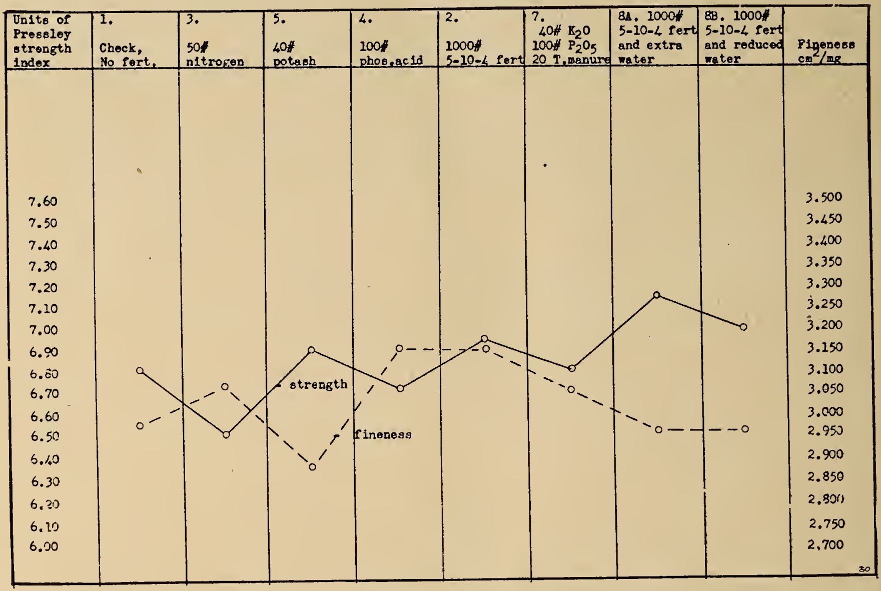

FIGURE 30. Relation of Strength and Fineness of Fiber Based on Means from Three Tagging Dates, 1943.

Relation of X-ray Angle of Fibrils in Cotton Fibers to the Strength of the Fibers

Probably most all who have examined cotton fibers with a microscope have observed numerous, more or less distinct, fine cellulose fibrils in the wall of the fiber which tend to extend around the wall in a somewhat spiral fashion.

Berkley (15) observed that in the primary layer of the cell wall the fibrils tend to be transverse to the long axis of the fiber but as the secondary layers of the fiber wall are formed, the fibrils change to a steeper spiral position and are more nearly parallel to the long axis of the fiber. This is a step in the development of the fiber and appears to lead to greater strength.

Figure 31 is based on data from cotton grown at Baton Rouge in 1943. Strength measurements were made with a Pressley strength tester by Simpson and associates in the Fiber Laboratory at Knoxville, Tennessee, and the x-ray angles were determined by Berkley, United States Department of Agriculture, D. C. If we notice the strength curve, we see that there is a general upward trend with the use of better fertilizers. There is a zigzag course which is probably not significant but may be due to experimental errors in testing, etc. The x-ray angles enlarge fairly regularly with the use of better fertilizers and the two curves show much the same general trend indicating that there is some relation between strength and the x-ray angle of the fibrils—the larger the angle, the stronger the fiber. Worked out statistically using data from 80 tests, we get a correlation coefficient of 0.3873, which is significant.

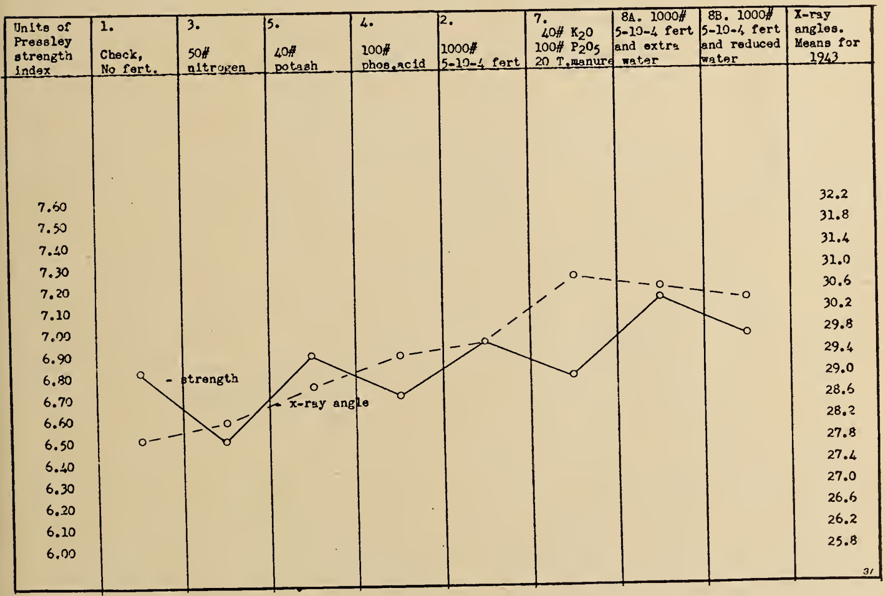

FIGURE 31. Relation of X-ray Angle of Fibrils in Cotton Fibers and Fiber Strength, Based on Means from Dated Bolls, Fiber Test, 1943.

A study of the fibril angle in 1943 in the lint from 259 samples from plots that received the same treatment (treatment 7) gave evidence that as the season progressed the angle became smaller. The angle mean from bolls tagged on June 30 was 32.01; for bolls tagged on July 7, 31.24; and for bolls tagged on July 20, 29.56. The strength of the fibers from the same dates, as measured on the Pressley strength tester, showed a similar decrease as the season advanced. Lint from bolls tagged on June 30 had a mean strength of 7.30 units; tagged on July 7, 6.81 units; and tagged on July 20, 6.36 units.

Similar studies of the relation of x-ray angle and strength were made on fiber samples grown in 1944. These tests gave an x-ray angle curve much like the one in 1943. There was an upward trend in the course of the curve with the use of better fertilizers. The strength curve, however, showed but little consistency and no apparent relation to the other curve. This may have been due in part to difference in the growth of the plants on different plots. As has been mentioned previously, the plants on the poorly fertilized plots were slow in growth and were much later in blooming than plants on the better fertilized plots, so that bolls collected on the same day on the two sets of plots are not comparable because they did not represent the same stage of plant development.

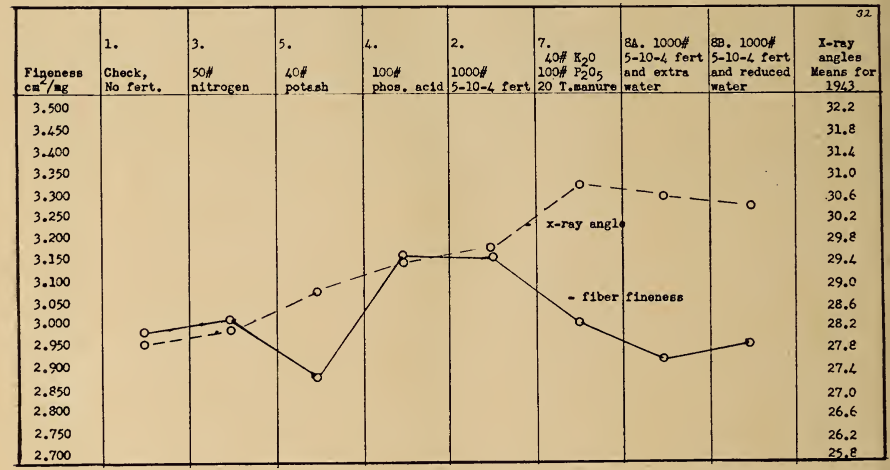

FIGURE 32. Relation of X-ray Angle of Fibrils in Cotton Fiber Walls and Fiber Fineness.

Some study was made of the relation of x-ray angle of the fibrils in the wall of cotton fibers and fiber fineness (Figure 32) but insofar as our data show there does not seem to be any definite relation. The fiber fineness curve, based on the fineness means of fibers from three different blooming dates during the season of 1943, shows no definite trend.

Some study was made also of the relation of the x-ray angle of the fibrils in the wall of cotton fibers and the length of staple, using for the length the upper half mean of fiber length as determined with Hertel's fibrograph. Means from three different tagging dates during the season of 1943 were used, the dates and plots for the two sets of tests just mentioned being the same.

A glance at the curves shown in Figure 33 indicates that there is some relation between fibril angle size and staple length. Both curves make a rather steady upward swing with the use of better fertilizers, but the correlation is not close.

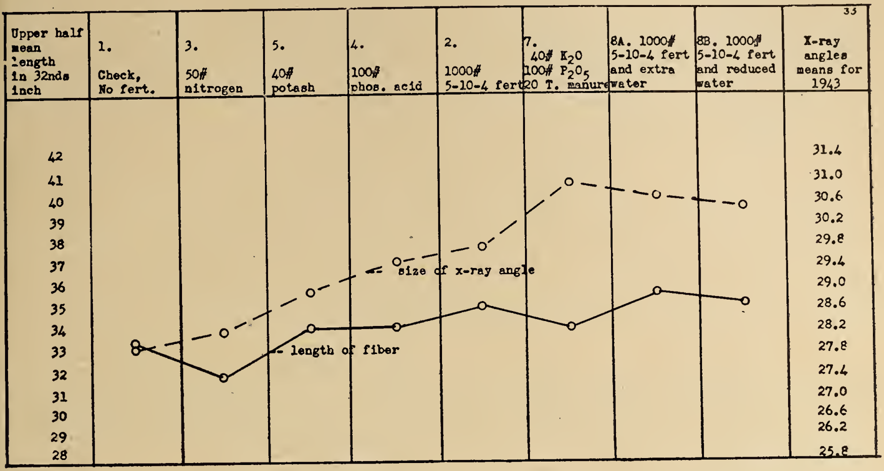

Figure 33. Relation of X-ray Angle of Fibrils in Wall of Cotton Fiber and Length of Fibers.

GENERAL

It is a difficult task to determine the specific effect of different fertilizer treatments on particular cotton plant characters. It is difficult because a character may be influenced by many factors—as different fertilizer ingredients, soil composition, temperature and moisture conditions, genetic factors, etc. To determine results with any degree of certainty experiments must be carried on under control conditions. One reason why much of the work done in the past has not given consistent results is that the investigators have ignored various factors that have a bearing on their problem. For instance, they have not considered the genetic constitution of the cotton variety or strain used. If an ordinary commercial variety is used, the natural variation in characters is enough to obscure effects due to treatments. Also, to cite another instance, but little attention has been paid to the stage in plant development at which the character in question was measured. This study has shown that, as a rule, under normal conditions early in the season the plant is apparently much more vigorous, producing more growth, more flowers, larger bolls, larger seed, longer staple, higher lint index, and coarser and stronger staple than later in the season. Several other illustrations of unconsidered factors could be mentioned.

In our experiments an effort was made to carry on the work under control conditions insofar as was feasible for experiments conducted in the field. In consequence, the results have been very consistent.

An environmental factor that affects or changes one character of a cotton plant usually affects other characters also. A liberal application of needed fertilizer induces greater vegetative growth and with this more fruiting and a higher percentage of boll set. There are even fewer diseased and defective bolls on the better fertilized plants.

The specific effect of individual fertilizer elements on particular characters of the cotton plant, especially on the elements that belong to cotton fiber quality, is a field that has been explored but little and is one that will require much detailed and careful study before definite conclusions can be reached.

SUMMARY

1. The main object of this investigation was to determine the specific effect of different fertilizer elements on cotton fiber quality. In the study rather striking effects on other characters of the cotton plant were observed and noted.

2. Since much of the study devoted to the subject mentioned has not given consistent or conclusive results, an effort was made to conduct the experiment under as nearly control conditions as is feasible in field crop work. A small cut of unfertile but uniform land was chosen for the experiment. Thirty-two small plots were laid off, the soil from these dug up and mixed by shoveling and put back on the plots. To avoid border effect a vacant space was left around each plot. Seed of a wilt-resistant strain of cotton that had been carried as a pure line for nine years was planted, and the seed treated with Ceresan to control seedling diseases. A perfect stand of plants on all plots was maintained by transplanting a few hills while plants were small. Rather heavy application of fertilizers was made in bands on both sides of the row of seeds about ten days prior to planting. The row cultivation was done with hoes to avoid the possibility of displacing some of the fertilizer. Bloom counts were made every day during the blooming season, and square and boll shed counts made once a week. Open bolls were counted, picked, and weighed. Many of the bolls were tagged with dated tags so that comparison could be made between bolls developed under the same weather conditions.

3. As is shown in Figure 1 and in Table 1, the better fertilizers had marked and consistent effect on the growth of the plants.

4. Blooming and shedding counts showed that under favorable conditions cotton plants do most of their blooming in July and that very few of the August blooms make bolls.

5. Nitrogen alone and potash alone produced no more blooms than the check, which had no fertilizer.

6. Superphosphate used alone gave a fair blooming rate and there were but few shed squares.

7. One thousand pounds of a complete fertilizer gave considerably more blooms than the phosphorus alone and there were fewer shed squares.

8. An application of 20 tons of barn manure with phosphorus and potash produced more blooms and less boll shedding than any other treatment.

9. A much higher percentage of boll set is obtained from blooms that appear early in the season and from blooms on well fertilized plots.

10. Good fertilizers shorten the boll period 6 to 8 days.

11. Larger bolls are produced on the better fertilized plots and by the blooms that open during the first half of the season.

12. Well fertilized plants produce a higher percentage of five-lock bolls than poorly fertilized ones. The difference may be as much as 30 per cent.

13. Four-lock bolls have more seeds per lock than five-lock, and up to a certain limit the number of seeds per lock increases with the fertilization.

14. Plants on well fertilized plots have higher seed index and seed with a higher oil percentage, but a lower percentage of ammonia.

15. The better fertilizers gave a higher lint index.

16. In 1943 the mean staple length from plots receiving the better fertilizers was about 5/32 inch longer than the staple from the unfertilized or poorly fertilized plots. There was a decided shortening of fibers as the season progressed, both on the well fertilized and poorly fertilized plots.

17. Staple lengths of the upper half means show about the same trends as the regular means.

18. Our studies showed no definite correlation between fiber fineness and plot treatment, but there was some relation between period of boll development and fiber fineness—the later bolls had finer fibers. This was probably due largely to more immature or thin-walled fibers in the later bolls.

19. Fibers from bolls on well fertilized plots and from early bolls had the best strength. Cotton from the early bolls also showed greater resilience.

20. Our material showed no definite correlation between fiber fineness, as determined by Hertel's arealometer, and fiber strength. Many of the finer fibers were probably immature.

21. Studies of the x-ray angle of the fibrils in the wall of the cotton fiber showed that the larger the angle the stronger the fiber. There was a positive correlation of 0.3873, which was significant. The angle became smaller as the season progressed.

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Louisiana Bulletin No. 407 September, 1946

A Twelve-Month Grazing Program for the Rice Area of Louisiana

By

R. K. Walker and M. B. Sturgis

Kobe Lespedeza after Rice on Oberlin Silt Loam.

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A Twelve-Month Grazing Program for the Rice Area of Louisiana

R. K. Walker and M. B. Sturgis

In the prairie rice area of southwestern Louisiana rice production and cattle raising are the two most important agricultural enterprises. When the land is not planted to rice, it is allowed to lie idle and grow weeds and grasses which are grazed by beef cattle. This practice has been carried on so long and with so little regard for the maintenance of the fertility of the soil that the yields of rice and beef are too low to support the most profitable agriculture. Research during the past few years has shown that the soils have lost over half of their original amount of organic matter and are low in available nitrogen, phosphorus and potassium (4, 5).[1] Flooding during the growth of rice and the large surface drainage losses following the removal of the crop increase soil depletion. It is particularly common to find the available nitrogen very low within three weeks after the rice is flooded (6). In order to provide a high level of available nitrogen throughout the growing period of rice, it was found that increasing the organic matter in the soil could be expected to give the best results (3, 5). Since there is a shortage of feed for cattle in the area and the production of beef on the extensive, unimproved, weedy pasture land which is being rotated in rice is somewhat less than 50 pounds of beef per acre per year, obviously the establishment of improved clover and grass pastures would increase the beef production (2) and the rotation of these pastures with rice would restore the soil organic matter. Local observations and work in Alabama (1) also indicated that oats planted in early September could be used for supplementary grazing through the winter months.

In order to develop methods for improving pastures and pasture management and to test the value of turning under pasture sods on the improvement of soil fertility, experiments were located in the distinctly different soil areas. There are at least four soil series groups in the prairie rice area (4). More particularly, the purposes of this investigation were to establish and study improved clover and grass pastures receiving different treatments, to determine the value of oat and lespedeza pastures as supplements to the mixed pastures, to evaluate the different pastures and treatments in terms of beef production and the effects of the sod from each pasture on the increase in the yield of rice, and to determine the effects of fertilizers applied directly to rice following the different pastures.

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[1] Figures in parenthesis refer to "Literature Cited."

EXPERIMENTAL PROCEDURE AND RESULTS

Experimental pastures were established at five different locations as indicated by data in the tables that follow. The following practices were used at each experiment. Water for the stock was supplied for each pasture and each pasture was equipped with a cattle-proof fence. The seedbed preparation consisted of breaking, discing, harrowing, and packing. The animals in each pasture were weighed at 30-day intervals. The number of animals grazed was determined by the condition of the pastures at the beginning and by the conditions of the animals and pastures as grazing progressed. As animals were finished others were substituted. Except for the experiment located at Kinder, the grazing data for the year during which the pastures were planted has not been included in the tables. All pastures were mowed to control weeds. Refertilization after the establishment as indicated was preceded immediately by scarifying the sod with a disc or a rotary pasture cultivator. All the experiments were located on land which had been cropped to rice in alternate years and from which a rice crop had been harvested preceding the planting of the pastures.

Pastures on Oberlin Silt Loam

A pasture-rice rotation experiment was located at Welsh, Louisiana, on Oberlin silt loam soil in 1941. Twenty-acre pastures were used and they received various treatments as indicated in Table 1. The seed mixture and the rate of seeding per acre was 4 pounds of white clover, 2 pounds of Persian clover, 10 pounds of common lespedeza, 6 pounds of carpet grass and 4 pounds of Bermuda grass, except pasture 4, which received 6 pounds of white clover, 10 pounds of common lespedeza, 10 pounds of Dallis grass, and 2 pounds of Bermuda grass.

The data in Table 1 show that the pastures which were fertilized could be grazed for a longer period. They supported more animal units per acre and produced much more beef per acre than did the pasture which was seeded only. The pastures that were treated with ground limestone in sufficient amounts to raise the pH to 6.2 and were seeded and fertilized gave higher yields of beef than the pastures which were not limed. In terms of beef yield liming, fertilizing and seeding produced 229 pounds per acre; fertilizing and seeding, 137 pounds per acre; and seeding only, 58 pounds per acre. The seasonal distribution of gains of the variously treated pastures is shown in Figure 1. The gain of beef per acre per day on the limed, fertilized, and seeded pasture was high in March, April, and May due especially to an excellent growth of clovers during this period. A sharp decline occurred in June and July, a period during which dry weather is usually encountered and during which the clover disappears. When the lespedeza was making a good growth in August,

TABLE 1 — Beef Production from Improvement of Pastures on Oberlin Silt Loam at Welsh, Louisiana

Pasture and Treatment	Days of grazing annually		Animal units per acre	Beef production, pounds per acre	Increase from treatments, pounds of beef per acre
	Days	Year			
1. Seeded only	184	1942	0.25	67	—
	196	1943	0.32	88	—
	229	1944	0.27	61	—
	137	1945	0.28	17	—
	194	av.	0.28	58	—
2. 400 lbs. per acre 4-12-8, 200 lbs. per acre 0-12-12 additional in 1943 and 1945, seeded	184	1942	0.33	142	75
	196	1943	0.37	133	65
	251	1944	0.36	89	28
	233	1945	0.34	185	168
	216	av.	0.35	137	79
3. 1.5 tons limestone, 400 lbs. per acre 4-12-8, 200 lbs. 0-12-12 additional in 1943 and 1945, seeded	184	1942	0.38	130	63
	196	1943	0.46	150	62
	251	1944	0.39	169	108
	233	1945	0.38	155	138
	216	av.	0.40	151	93
4.* 2.0 tons limestone, 400 lbs. per acre 3-12-12, 200 lbs. 0-12-12 additional in 1945, seeded	251	1944	0.46	234	163
	233	1945	0.41	224	212
	242	av.	0.44	229	188

*This pasture was established in 1943.

Unimproved Pasture after Rice on Oberlin Silt Loam.

Improved Pasture of Clover, Lespedeza, and Dallis Grass on Oberlin Silt Loam.

the gains rose and remained fairly constant, and about 0.6 pound per acre per day was produced until frosts occurred in November. The gains from the pasture that received fertilizer and seed only followed a similar pattern, except that the grazing peak was later and yields were lower owing to the absence of clover, which did not survive in the unlimed pastures. The pasture that was seeded only reached its relatively low peak in June and then fell to a lower level for the remainder of the grazing season.

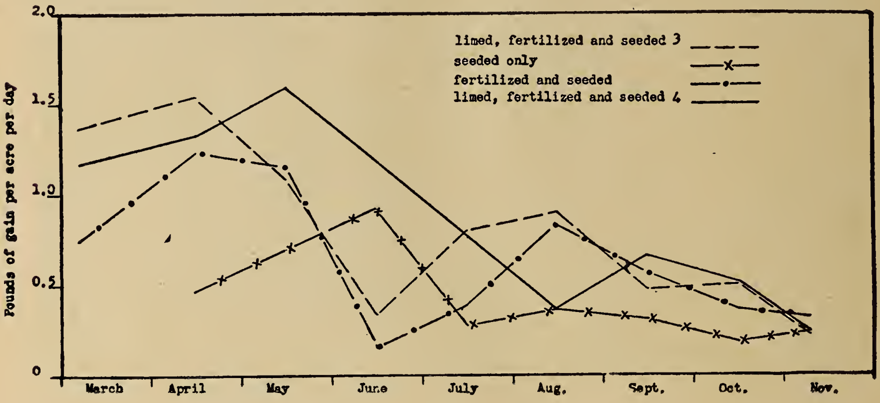

Figure 1 — Seasonal Distribution of Gain from Pastures on Oberlin Silt Loam at Welsh, Louisiana, 1942-45.

A similar pasture-rice rotation experiment was begun at Kinder, Louisiana, in 1942 on Oberlin silt loam. Four 20-acre pastures that received treatments as shown in Table 2 were established. The seed mixture consisted of white clover, hop clover, Persian clover, common lespedeza, and carpet grass. Data in Table 2 show that in beef production for the grazing period an average of 14 pounds per acre was received from the check pasture, 28 pounds per acre from the pasture that was seeded only, 93 pounds per acre from the pasture that was seeded and fertilized, and 172 pounds per acre from the pasture that was seeded, fertilized, and limed, while the number of animal units grazed per acre averaged 0.10, 0.15, 0.29, and 0.37, respectively. Figure 2 shows that the production of beef per acre per day was much higher in April and May on the pasture that was seeded, fertilized, and limed, owing to its being the only pasture in which clover survived. The general seasonal trend in the other two treated pastures was the same except the gains were lower. The production of beef per acre per day was extremely low throughout the grazing season on the check pasture. After three years of grazing, these pastures were planted to rice. The yields of rice after the variously treated pastures and from the fertilizer treatments at time

TABLE 2 — Beef Production from Improvement of Pastures on Oberlin Silt Loam at Kinder, Louisiana

Pasture and Treatment	Days of grazing annually		Animal units per acre	Beef production, pounds per acre	Increase from treatments, pounds of beef per acre
	Days	Year			
1. Seeded only	142	1942	0.16	18	6
	193	1943	0.15	31	8
	222	1944	0.15	36	29
	186	av.	0.15	28	14
2. 400 lbs. per acre 4-12-8, 200 lbs. per acre 0-12-12 additional in 1944, seeded	142	1942	0.21	50	38
	193	1943	0.29	85	62
	222	1944	0.36	145	138
	186	av.	0.29	93	79
3. 1.5 tons limestone, 400 lbs. per acre 4-12-8, 200 lbs. per acre additional in 1944, seeded	142	1942	0.30	154	142
	193	1943	0.34	145	122
	222	1944	0.48	217	210
	186	av.	0.37	172	158
4. Check — no treatment	142	1942	0.10	12	—
	193	1943	0.14	23	—
	168	1944	0.05	7	—
	168	av.	0.10	14	—

of planting rice are shown in Table 3. An increase of 6.0 barrels of rice was received from 200 pounds of 4-12-8 at time of planting after the sod of the check pasture. Increases of 1.1 barrels of rice from sod only and 7.8 barrels of rice from sod and 200 pounds per acre of 4-12-8 after the check pasture were received. After the pasture that had been seeded and fertilized increases of 5.0 barrels from sod and 9.0 barrels from sod and fertilizer were received; while after the pasture that had been seeded, fertilized and limed an increase of 11.1 barrels was received from sod and 13.2 barrels from sod and fertilizer.

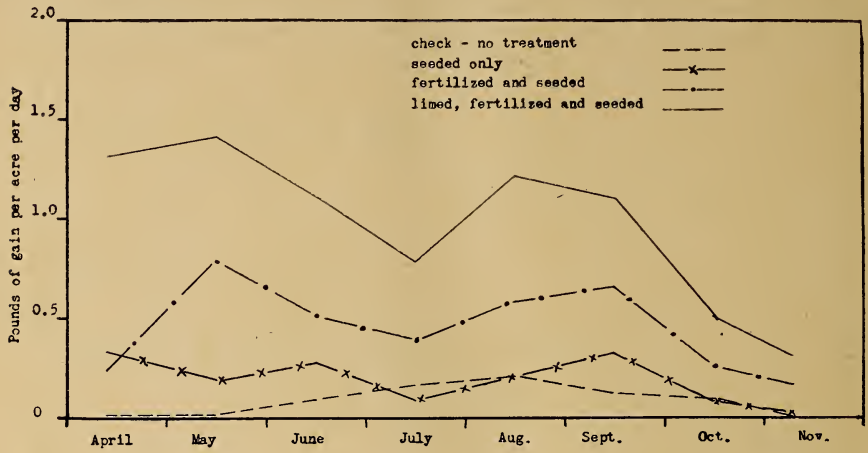

Figure 2 — Seasonal Distribution of Gain from Pastures on Oberlin Silt Loam at Kinder, Louisiana, 1942-44.

In 1944 a pasture of oats rotated with Kobe lespedeza was established at Welsh, Louisiana, in connection with the improved pasture experiment. Kobe lespedeza was seeded at the rate of 30 pounds per acre and fertilized with 300 pounds of 5-10-5. A yield of 1.1 tons of lespedeza hay was harvested. Oats were seeded on this pasture in October. The cattle that had been grazed on the permanent pastures were removed November 7, 1944, and placed in the rice stubble fields, where they continued to gain until January 2, when they were placed in the oats pasture and grazed until March 8. Five heifers gained 440 pounds on eight acres, or an average gain of 0.90 pound per acre per day. The oats were top-dressed with 200 pounds of nitrate of soda, and 21 bushels of oats were harvested. A volunteer crop of lespedeza which yielded 1.5 tons of lespedeza hay per acre was produced in 1945. Oats for winter grazing were seeded in October, 1945.

Pastures on Lake Charles Silty Clay Loam

In 1943 a pasture-rice rotation experiment was located at Chloe, Louisiana, on Lake Charles silty clay loam. It consisted of four 16-acre pas-

TABLE 3 — Rice Yields after Pastures on Oberlin Silt Loam at T. H. Mayes', Kinder, Louisiana

Pasture treatments before the rice crop	Fertilizer treatment at planting	Yield of rice in barrels per acre	Increase in yield from 200 lbs. 4-12-8, in barrels per acre	Increase over checks, in barrels per acre, due to sod and fertilizer
1. 400 lbs. 4-12-8, 1.5 tons ground limestone per acre (1942) seeded	No fertilizer	17.1		11.1 sod
200 lbs. 0-12-12 (1944)	200 lbs. 4-12-8	19.2	2.1	13.2 sod and fertilizer
2. 400 lbs. 4-12-8 (1942), seeded	No fertilizer	11.0		5.0 sod
200 lbs. 0-12-12 (1944)	200 lbs. 4-12-8	15.0	4.0	9.0 sod and fertilizer
3. Seeded only (1942)	No fertilizer	7.1		1.1 sod
	200 lbs. 4-12-8	13.8	6.7	7.8 sod and fertilizer
4. Check — no fertilizer	No fertilizer	6.0		—
No seeding	200 lbs. 4-12-8	12.0	6.0	

tures treated as indicated in Table 4. The seed mixture was composed of white clover, common lespedeza, carpet grass, Dallis grass, and Bermuda grass. The data in Table 4 show that the pasture that received seed and 400 pounds of 3-12-12 per acre produced more beef per acre and had a larger grazing capacity than any of the other pastures. Liming proved unnecessary on Lake Charles silty clay loam, as the pH was 6.55 and 7.10 in the surface and subsoil, respectively, before liming. The data in Table 4 also show that the pasture that received nitrogen in the fertilizer treatment produced 293 pounds of beef per acre compared to 200 pounds per acre produced on the pasture that was fertilized with 0-12-12. The seasonal distribution of gains expressed in pounds of beef per acre per day is shown in Figure 3. The clover peak occurred in March and April. The clover disappeared in late May and early June and the rise in beef yields in July due to good growth of lespedeza is similiar to the seasonal distribution in gains from pastures on Oberlin silt loam. Clover was well established on all pastures that received phosphate and potash fertilizer, while it did not survive in the pasture that was seeded only.

An oat and lespedeza supplemental pasture was established in connection with this pasture experiment in 1944. Kobe lespedeza was seeded at the rate of 30 pounds per acre and fertilized with 300 pounds of 3-12-12. A crop of 1.1 tons of hay per acre was harvested, and oats were planted in October and fertilized with 300 pounds of 5-10-5. The animals that had been grazed on the improved pastures were removed and placed

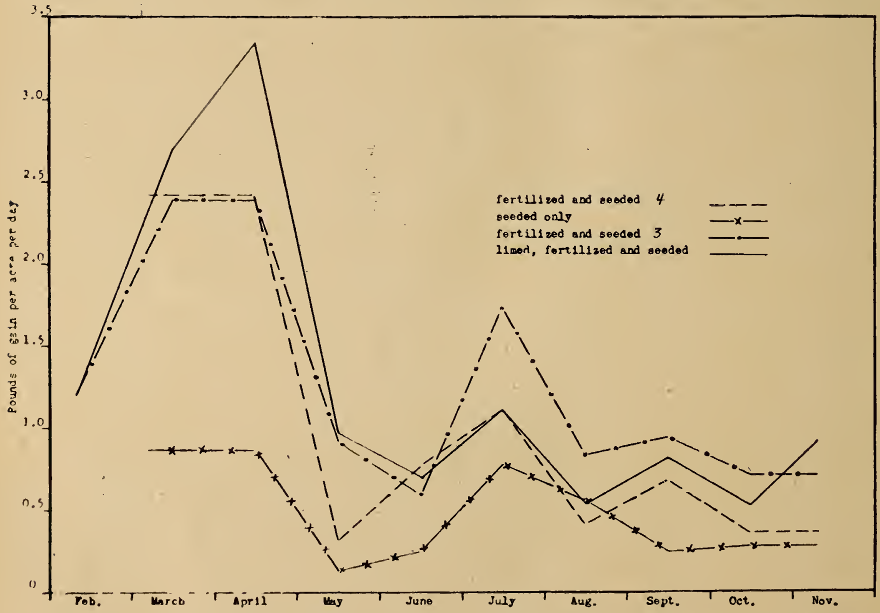

Figure 3 — Seasonal Distribution of Gain from Pastures on Lake Charles Silty Clay Loam at Chloe, Louisiana, 1944-45.

TABLE 4 — Beef Production from Improvement of Pastures on Lake Charles Silty Clay Loam, Mound Phase, at Chloe, La.

Pasture and Treatment	Days of grazing annually		Animal units per acre	Beef production, pounds per acre	Increase from treatments, pounds of beef per acre
	Days	Year			
1. Seeded only	232	1944	0.27	121	—
	238	1945	0.33	79	—
	235	av.	0.30	100	—
2. 400 lbs. per acre 3-12-12, 200 lbs. per acre 0-12-12 additional in 1945, seeded	232	1944	0.54	292	171
	279	1945	0.42	293	214
	256	av.	0.48	293	193
3. 1 ton limestone, 400 lbs. per acre 3-12-12, 200 lbs. per acre additional in 1945, seeded	232	1944	0.46	270	149
	279	1945	0.42	278	199
	256	av.	0.44	274	174
4. 400 lbs. per acre 0-12-12, 200 lbs. per acre 0-12-12 additional in 1945, seeded	232	1944	0.38	194	75
	238	1945	0.43	205	126
	235	av.	0.41	200	101

in the rice stubble fields November 5, 1944, where they continued to gain until the second growth of rice and grasses was cleaned up. The cattle were placed on the oats December 19, 1944, with an average of one animal unit to 1.4 acres and were grazed continuously until March 5, 1945, when the permanent pastures were again ready to be grazed. The animals gained an average of 92 pounds of beef per acre during the 76-day period on oats. The animals were removed and 200 pounds per acre of nitrate of soda were applied to the oats. Twenty-five bushels of oats were harvested in June.

Pastures on Crowley Silty Clay Loam

A pasture-rice rotation experiment was located at Abbeville, Louisiana, on Crowley silty clay loam in 1942. The 20-acre pastures were grazed 246 days in 1943. The check pasture produced 77 pounds of beef per acre and carried 0.17 of an animal unit per acre. The pasture which was seeded only produced 101 pounds of beef per acre and carried 0.24 of an animal unit. The pasture that was seeded and fertilized with 400 pounds per acre of 0-12-6 produced 173 pounds of beef per acre and supported 0.30 of an animal unit; while the pasture that was seeded, fertilized with 400 pounds of 3-12-6, and limed with 1 ton of ground limestone produced 214 pounds of beef per acre and furnished grazing for 0.35 of an animal unit.

Rice was planted at the Abbeville location in 1944 following two years of grazing, and the yields obtained are shown in the data in Table 5. An increase of 0.6 barrel of rice per acre was obtained from 200 pounds of 4-12-8 after the check pasture. An increase over the check pasture of 1.3 barrels of rice due to sod and 2.3 barrels due to sod and fertilizer was received following the pasture that was seeded only. An increase in yield over that of the check pasture of 0.4 barrel due to sod and 0.9 barrel due to sod and fertilizer was received from the pasture that had been seeded and fertilized with 400 pounds of 0-12-6. After the pasture that received seed, 400 pounds of 4-12-8 and 1 ton of ground limestone per acre an increase in the yield of rice of 6.5 barrels was obtained over the check pasture. Of this increase 6.4 barrels were due to the effect of the pasture sod.

Another pasture-rice rotation experiment was located at Rayne, Louisiana, in 1943 on Crowley silty clay loam. Here 10-acre pastures were treated as shown in Table 6. The seed mixture consisted of 6 pounds per acre of white clover, 10 pounds of common lespedeza, 12 pounds of Dallis grass, and 2 pounds of Bermuda grass. The data in Table 6 show that the check pasture that received no treatment produced an average of 59 pounds of beef per acre and carried an averge of 0.19 of an animal unit per acre; the pasture that received only seed produced an average of 106 pounds of beef per acre and carried an average of 0.30 of an

TABLE 5 — Rice Yields after Pastures on Crowley Silty Clay Loam at J. F. Noel's, Abbeville, Louisiana

Pasture treatments before the rice crop	Fertilizer treatment at planting	Yield of rice in barrels per acre	Increase in yield from 200 lbs. 4-12-8, in barrels per acre	Increase over checks, in barrels per acre, due to sod and fertilizer
1. 400 lbs. 3-12-6, 1 ton ground limestone per acre, seeded (1942)	No fertilizer	21.6		6.4 sod
	200 lbs. 4-12-8	21.7	0.1	6.5 sod and fertilizer
2. 400 lbs. 0-12-6, seeded (1942)	No fertilizer	15.6		0.4 sod
	200 lbs. 4-12-8	16.1	0.5	0.9 sod and fertilizer
3. Seeded only (1942)	No fertilizer	16.5		1.3 sod
	200 lbs. 4-12-8	17.5	1.0	2.3 sod and fertilizer
4. Check — no fertilizer No seeding	No fertilizer	15.2		—
	200 lbs. 4-12-8	15.8	0.6	—

animal unit per acre. The pasture that was fertilized with 400 pounds per acre of 3-12-12 in addition to being seeded produced 246 pounds of beef per acre and carried 0.45 of an animal unit. A yield of 269 pounds of beef per acre was obtained and 0.42 of an animal unit was grazed on the pasture that received 1 ton of ground limestone in addition to fertilizer and seed. Figure 4 shows that the limed, fertilized and seeded pasture gave the most uniform seasonal distribution of grazing, with a gradual decline in gains after the clover period was over in June. The fertilized and seeded pasture was quite erratic in its production, with a relatively high gain in March and a decline until July, after which a rise occurred which can be attributed to a good growth of lespedeza. The two pastures that were not fertilized gave somewhat higher yields in March, April, and May than in succeeding months.

Figure 5 shows the average seasonal distribution of gain of beef per acre obtained from three treatments that were used in all the experiments. From March to July the gain was considerably higher on the limed and fertilized pastures than on the other pastures. From July to the end of the grazing season the limed, fertilized, and seeded pastures and the pastures that were fertilized and seeded were similar except that the gains from the former were consistently higher. Gains on the pastures that were seeded only averaged about 0.5 pound of beef per acre per day in the spring and dropped off fairly evenly from July to November, when the yield was only about 0.3.

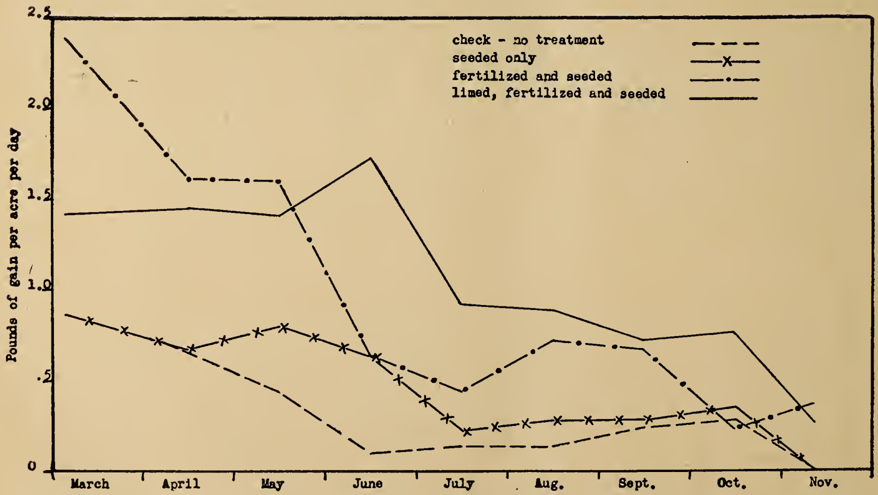

Figure 4 — Seasonal Distribution of Gain from Pastures on Crowley Silty Clay Loam at Rayne, Louisiana, 1944-45.

TABLE 6 — Beef Production from Improvement of Pastures on Crowley Silty Clay Loam at Rayne, Louisiana

Pasture and Treatment	Days of grazing annually		Animal units per acre	Beef production, pounds per acre	Increase from treatments, pounds of beef per acre
	Days	Year			
1. Seeded only	247	1944	0.27	133	68
	162	1945	0.32	78	25
	205	av.	0.30	106	47
2. 400 lbs. per acre 3-12-12, 200 lbs. per acre 0-12-12 additional in 1945, seeded	247	1944	0.45	215	150
	256	1945	0.45	276	223
	252	av.	0.45	246	187
3. 1 ton limestone, 400 lbs. per acre 3-12-12, 200 lbs. per acre additional in 1945, seeded	247	1944	0.41	231	166
	256	1945	0.43	307	254
	252	av.	0.42	269	210
4. Check — no treatment	213	1944	0.19	65	—
	228	1945	0.19	53	—
	221	av.	0.19	59	—

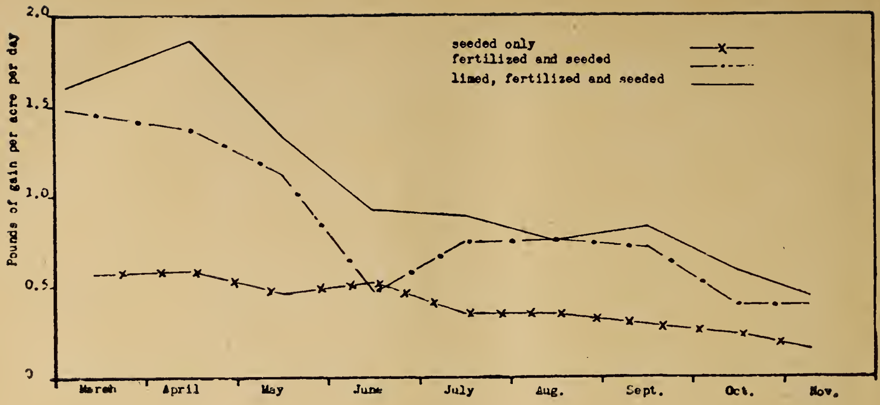

Figure 5 — Average Seasonal Distribution of Gain from Pastures at Welsh, Kinder, Chloe, and Rayne, Louisiana, 1942-45.

SUMMARY AND CONCLUSIONS

Pasture-rice rotation experiments conducted in three different soil areas of the prairie rice area of Louisiana have shown that a twelve-month grazing program can be developed. The rotation of improved pastures with rice is definitely the best means found thus far for increasing the yields of rice and for improving the soil productivity of the area.

Improved clover-grass-lespedeza pastures have been established on Oberlin silt loam, Lake Charles silty clay loam and Crowley silty clay loam by seedbed preparation, seeding, fertilizing with complete fertilizers high in phosphorus and potassium, and liming where the pH of the soil is below 6.2. These improved pastures have produced from 172 to 293 pounds of beef per acre during an approximately eight-month grazing period. The yields of the improved pastures exceeded the yields of the unimproved pastures over 150 pounds of beef per acre. The turning under of the improved pasture sods ahead of rice crops increased the yields of rice 6.4 and 11.1 barrels per acre.

Supplementary oat and lespedeza pastures rounded out the year-long grazing period and furnished a source of grain and hay which could have further supplemented the mixed pastures during periods of low grazing capacity. The grazing value of the oats as a pasture was 92 pounds of beef per acre during the period from December to March.

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LOUISIANA BULLETIN NO. 408 NOVEMBER 1946

SOIL ROT OF SWEET POTATOES AND ITS CONTROL WITH SULPHUR

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SOIL ROT OF SWEET POTATOES AND ITS CONTROL WITH SULPHUR

L. H. PERSON*

The disease of sweet potatoes known as soil rot was first observed to be developing in a serious form in Louisiana in about 1934. In the years immediately following, 1935 and 1936, the disease caused serious losses on several farms in the vicinity of Sunset, and it was these outbreaks that led to the study of the disease and to the methods of control presented in this bulletin.

Symptoms

The presence of the disease in the field is easily recognized, as the symptoms are different from those of any other sweet potato disease. At first small areas in the field are observed where the potato slips or cuttings fail to grow normally and vine. These areas may be circular, triangular, or irregular in shape, becoming larger each year as infested soil is scattered throughout the field by cultivation or other means. In Figure 1 is shown a field with

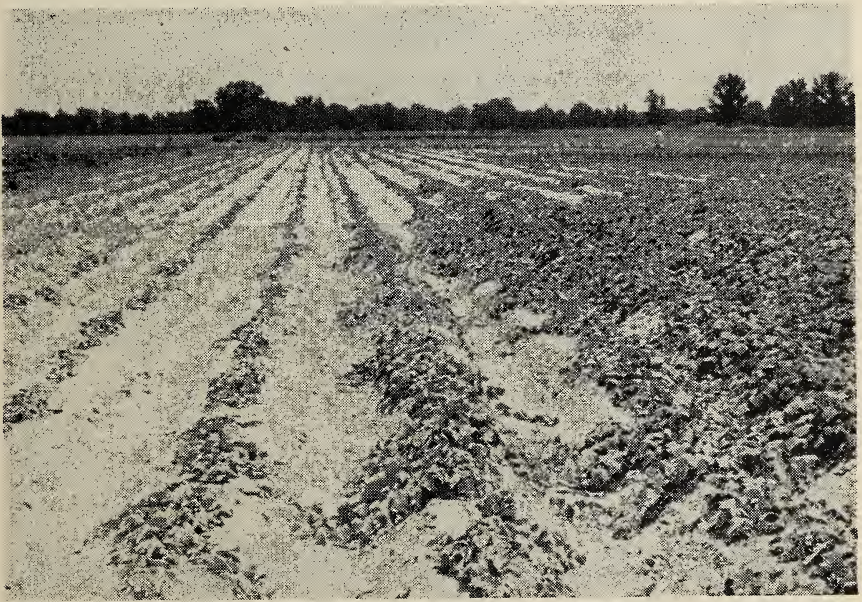

Fig. 1.—Soil rot in sweet potato field. Infection heavy in left half of the field.

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*The author wishes to acknowledge the assistance rendered by various companies and individuals: Freeport Sulphur Company for a grant and for the donation of sulphur; Southern Acid and Sulphur Company for donation of sulphur; the farmers on whose properties the tests were made; A. K. Smith and G. B. Martin, County Agents in St. Landry Parish; W. J. Martin, H. Steelman, A. J. Benton, C. A. Thomas, and P. H. Dunckelman, graduate students in the Department of Botany, Louisiana State University, who assisted in the work.

all the plants on one side affected and with the disease spreading to other areas in the back of the field. In such a field the disease usually becomes general in a few years and the field becomes worthless for the growing of sweet potatoes. The diseased areas can also be recognized by the presence of grass and weeds, which appear when the plants infected with soil rot fail to grow and cover the ground.

In heavily infested soil the plants fail to grow and make little or no vine growth. The plants appear as though conditions are unfavorable for growth, the leaves remain small and are pale green to yellow in color. Many of the plants die before the end of the season. The plants are easily pulled from the ground and

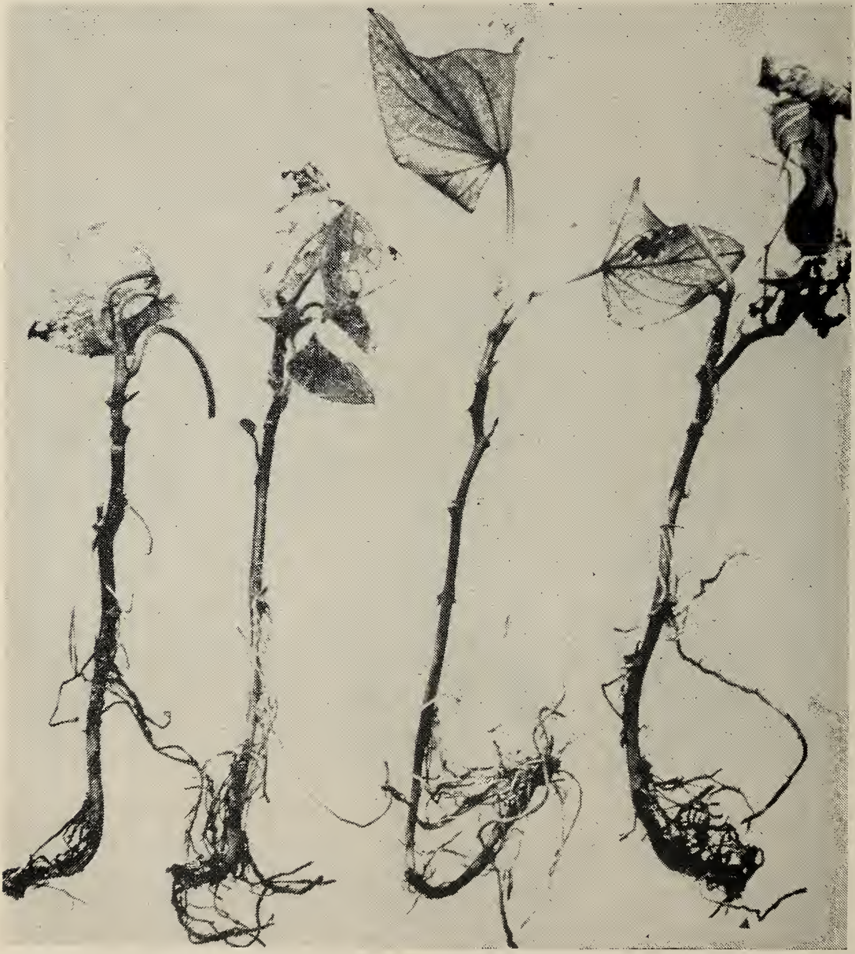

Fig. 2.—Young sweet potato plants affected with soil rot. Roots severely rotted.

the root systems are very poorly developed, most of the roots being entirely rotten and many of them breaking off when the plants are lifted from the soil (Fig. 2). The disease is also found on the mature potatoes in the form of pits or scabby cavities with irregular jagged or roughened margins. The spots on the potatoes may vary in size, sometimes covering a greater part of the potato. Many of the potatoes are also badly misshapen (Fig. 3).

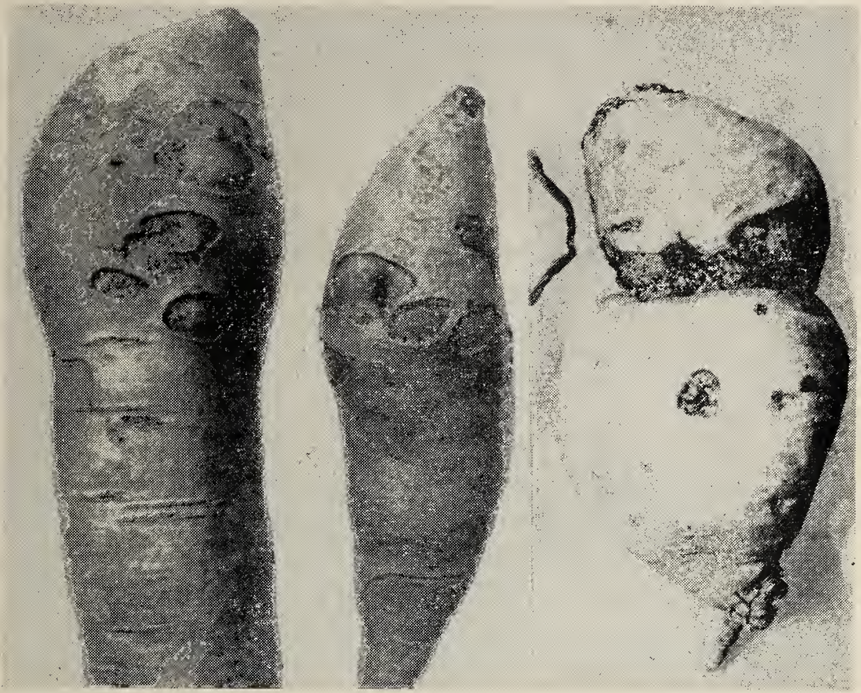

Fig. 3.—Scab-like lesions on sweet potatoes caused by soil rot.

In fields that are only lightly infested the plants may vine and appear to be perfectly normal in growth, but at digging time the crop yields are disappointing. In such fields, the potatoes are often scabby and misshapen and frequently only one large (jumbo) potato is found on a plant. The disease organism, however, builds up in succeeding years, and when sweet potatoes are again planted the severe stunting type of the disease becomes evident.

Occurrence and Importance of Soil Rot

The soil rot when first noticed in 1934 was present in severe form in a few small spots in several fields near Sunset, St. Landry Parish. The disease spread rapidly in the succeeding years and a survey made in 1937 showed the disease to be present on 83 farms in St. Landry Parish, principally near the towns of Sunset, Arnaudville, and Leonville. Since this survey was made the disease has been seen on many additional farms in this area. In addition to St. Landry Parish, it has also been found in St. Martin, Lafayette, Caddo, Ouachita, Rapides, Vernon, and West Carroll Parishes. It is very probable that it occurs in other parishes of the state.

This disease is causing a serious economic problem in St. Landry Parish. In 1935 some fields were so severely diseased that they were abandoned, and in 1936 a larger number of fields were plowed up and planted to soybeans, or left to grow up in grass and weeds because the potatoes failed to grow after being set in the fields. Similar fields were seen in 1937, 1938, 1943, 1944, and 1945.

Environmental Relationships

The severity of soil rot is influenced by two factors: (1) the water content of the soil (amount and distribution of rainfall), and (2) the hydrogen-ion concentration (acidity) of the soil.

In the past decade, in years in which the rainfall was abundant during the early part of the growing season, such as 1941, 1942, and 1946, satisfactory yields were obtained in fields known to be heavily infested with the soil rot organism. On the other hand, in dry years such as 1938, 1943, and 1944, the disease caused very severe losses, in some areas causing the total destruction of certain fields. Even in years in which the rainfall was considered more or less normal, severe losses occurred.

Also in acid soils in which the hydrogen-ion concentration is below pH 5.2, there has been but little loss from the disease. The soil rot organism does not seem to be able to develop or survive in such soils.

Cause and Spread of the Disease

This disease is caused by an organism, *Actinomyces ipomoea*, that lives in the soil. It is known that the disease organism will live in the soil in Louisiana for at least eight years and probably much longer. In other states records show that the organism is still active in the soil after periods of twenty-five years.

The chief means of spread seems to be through the transfer of infested soil or infected seed potatoes from one place to another. The spread may be brought about by farm implements, drainage water, or by livestock that roam from a diseased field into clean fields. The chief method of spread from one locality to another is by the shipment of infected sweet potatoes or sweet potato plants, or from infested soil adhering to the potatoes.

Control Investigation

When the disease first became a problem in the state, tests were made which indicated that it would not develop on an acid soil with the pH below 5.2. As it was known that the acidity of the soil can be raised, or the pH lowered, by the application of sulphur, a preliminary test was made to determine whether the disease could be reduced or eliminated by sulphur applications.

The preliminary test with sulphur was made in 1937 on the farm of Mr. John deValcourt near Sunset. The field selected for the test had been planted to sweet potatoes in 1936, but the plants failed to grow and the crop was a total loss. The sulphur was applied to the soil at rates of 400, 700, and 1,000 pounds per acre six weeks before the plants were set in the field. The 400-pound application did not adequately control the disease, as the plants made only slightly better growth than did those in other parts of the field receiving no sulphur. In the plots receiving the 700-pound and 1,000-pound applications the plants made good growth and satisfactory yields were obtained (Fig. 4). The yields on the various plots measured in 50-pound crates of No. 1 and No. 2 potatoes per acre were as follows: controls (no sulphur), 1½ crates; 400-pound rate, 21 crates; 700-pound rate, 94½ crates; and 1,000-pound rate, 112 crates.

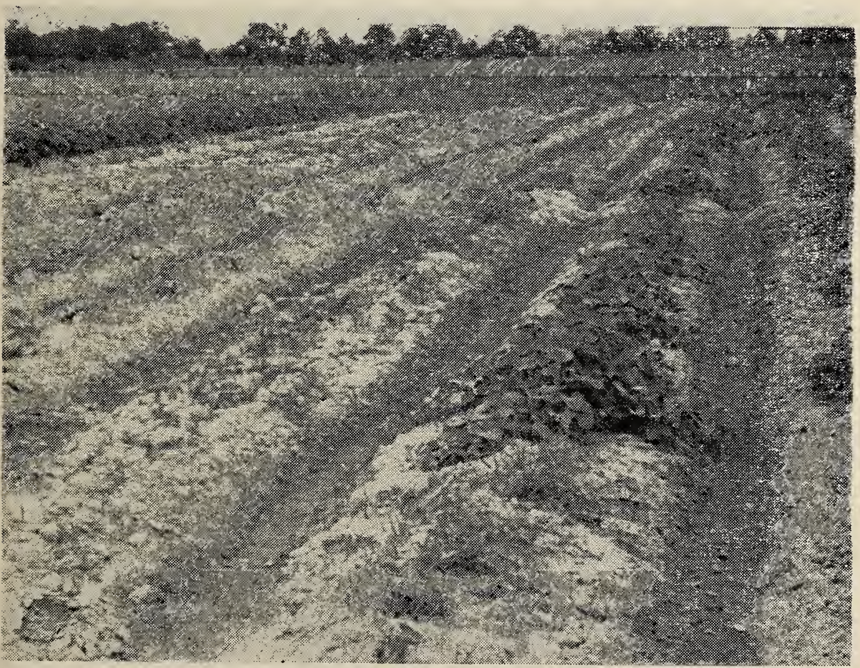

Fig. 4—Effect of sulphur on soil rot. Rows to right treated with sulphur, rows to left not treated.

Since the preliminary test indicated that the soil rot could be controlled by applying sulphur to the soil, larger and more extensive field tests were planned and started. These tests were planned to furnish information on the following: (1) amount of sulphur necessary to reduce the pH of the soil to about 5.0; (2) the period of time after treatment in which the pH would remain 5.2 or lower; (3) the effect of the treatment on the soil rot; and (4) the effect of the treatment on the yield of sweet potatoes.

Results have now been obtained from many tests made during a period of eight years and sufficient information has been obtained to make definite recommendations in regard to the use of sulphur in sweet potato fields.

Sulphur was applied to the soil on 20 farms in three areas in St. Landry Parish. With the exception of one farm, the soil was of the Lintonia silt loam type. The soil on this one farm was Miller silt loam, a reddish soil similar in appearance to the alluvial soil of the Red River. The Lintonia silt loam soil type is found on the greater portion of the farms in the sweet potato area in St. Landry Parish. The pH of the Lintonia soil is ordinarily 5.7 to 5.8 and of the Miller soil 6.1 to 6.2.

The general procedure for applying the sulphur was the same in all tests. After the field was leveled by plowing or discing, the sulphur was applied with a seed drill and disced into the soil as soon as possible after application. The soil was then thrown up into ridged rows. The sulphured plots were usually 7 to 10 rows wide, although in a few early tests they were only 5 rows wide. The unsulphured control plots were 5 or more rows wide. All plots were 200 or more feet in length.

Five types of sulphur were used:

1. **Commercial flour:** a sulphur 90 per cent of which passes through an 80 mesh screen;
2. **Stauffer granular:** a sulphur which passes through a 16 mesh screen;
3. **Toro:** a conditioned sulphur containing 14 per cent filler, 93 per cent of which passes through a 325 mesh screen;
4. **Soil sulphur:** a ground crude sulphur of 99.5 per cent purity;
5. **Inoculated sulphur:** a sulphur to which sulphur bacteria had been added.

Soil samples were collected periodically from each plot and pH readings were made. After a plot was sulphured, samples were collected several times in the first six months to determine the time necessary for the pH to drop to 5.0 or lower. After that, soil samples were taken one or more times a year until 1945 or until the plots were out of cultivation.

When the plots were harvested, the three center rows were dug and the potatoes were graded by the farmer. The yields were then calculated in 50-pound crates of No. 1 and No. 2 sweet potatoes per acre.

Effect of Sulphur on pH of Soil

In order to determine the amount of sulphur necessary to lower the pH of the soil to 5.0 and to maintain it near that level, four rates of application per acre were used: 500 pounds, 600 pounds, 700 pounds, and 800 pounds. The effect of these amounts on the pH of the Lintonia soils for a period of seven years is given in Table 1. As similar results were obtained with all the different sulphurs, the results are grouped in the table. The soil sulphur was slightly slower in action, taking about a month longer to bring the pH down to the level produced by the others, but after that the results with all were similar. The data in Table 1 represent averages. The 500-pound application was sufficient to lower the pH to a satisfactory level, but did not hold it there. As the pH in the plots receiving the 500-pound application had a tendency to rise after the first year, the applications in the following years were mostly 600 to 800 pounds. The 600-, 700-, and 800-pound applications all held the pH to 5.0 or slightly below for about four years, after which it tended to rise to 5.2 to 5.4. It usually required from two to four months after the sulphur was applied for the pH to drop to 5.0.

Results obtained on the Miller silt loam were quite different from those on the Lintonia soils. Applications of sulphur up to 800 pounds per acre barely lowered the pH to 5.0 within the first six months. However, this low level was not maintained. The pH began to rise gradually and within a year was 5.4 or above and continued to rise in later years. The lowering of the pH to 5.0 by the application of sulphur did not seem practical on this soil type and further tests were not made.

TABLE 1.

Effect of Sulphur on Soil pH on 19 Farms in St. Landry Parish, La.
(pH at Different Periods after Sulphuring.)

Sulphur applied per acre	1-2 mos.	3-4 mos.	5-6 mos.	1 yr.	2 yr.	3 yr.	4 yr.	5 yr.	6 yr.	7 yr.
No sulphur	5.7	5.8	5.8	5.9	5.7	5.6	5.7	5.7	5.7	5.7
500 lbs.	5.2	4.9	4.9	5.0	5.2	5.3	5.1	5.1	5.1	5.2
600 lbs.	5.1	4.9	4.7	4.9	4.9	4.9	5.0	5.2	5.4	5.4
700 lbs.	5.1	4.9	4.7	4.8	4.8	5.0	5.0	5.0	4.8	5.2
800 lbs.	5.1	4.9	4.6	4.8	4.8	4.8	4.9	5.2	5.2	5.3

Effect of Sulphur on Yields

During the eight years, from 1938 to 1945, yields were obtained from the plots to which sulphur had been applied. In the sweet potato area a rotation is usually followed, and so in most cases sweet potatoes were grown on the sulphured plots only once in every two or three years. In the eight years, yield data were obtained from 60 tests.

These tests were not entirely comparable. They were made in different years under various weather conditions; the period of time elapsing after the sulphur was applied varied; in some tests it was not possible to set out all of the plants at the same time; in some instances soil moisture conditions were favorable at planting time and in others they were not; often the infestation with the soil rot organism was not equally distributed in the field, the plants in some plots being more severely injured by the disease than those in others. However, it is felt that with the exception of those obtained in 1940, the results being presented are reasonably representative and show fairly accurately what may be expected from applying sulphur to fields infested with soil rot. In 1940, a flood in August put many of the fields under water and the plants in both the sulphured and the unsulphured plots were badly injured.

The results which were obtained during the eight years are presented in Table 2. These include all tests, those made the first year after applying the sulphur as well as those made from two to eight years after applying the sulphur.

TABLE 2.

Average Yields per Acre in 50-pound Crates, on Sulphured and Unsulphured Plots.

Year	No. of tests	Rate of sulphur applied per acre					Moisture condition
		No sulphur	500 lbs.	600 lbs.	700 lbs.	800 lbs.	
1938	8	8.0	77.4	99.1	66.9	83.3	Dry
1939	9	112.8	138.5	133.2	124.7	111.7	Normal
1940	10	57.9	....	74.7	69.4	63.5	....
1941	12	123.0	116.9	115.2	186.5	113.1	Wet
1942	5	156.3	139.0	166.0	137.1	156.0	Wet
1943	5	56.8	94.1	114.5	123.6	125.2	Dry
1944	6	35.4	....	156.7	....	177.9	Dry
1945	5	81.1	102.6	127.4	111.6	149.3	Normal

In evaluating the results included in the table, it should be recognized for the reasons listed above that they are not strictly comparable, and on this account variations shown in the different rates of application should not be considered significant.

Owing to the fact that some growers in St. Landry Parish will be interested in obtaining the details of the tests on individual farms, the results on the farms of John deValcourt and J. R. Barry are being included and are presented in Tables 3 and 4. The tests on these farms were continued over a series of years and give an idea of what can be expected from sulphur applications.

It was on the properties of John deValcourt that the soil rot disease was first recognized in Louisiana. These properties were very severely infested with the soil rot organism. The results obtained on these properties are given in Table 3.

TABLE 3.

Effect of Sulphur on Yields of Individual Plots on Properties of John deValcourt, Sunset, Louisiana. Yields Based on Crates of No. 1 and No. 2 Potatoes per Acre.

	Year and Moisture Conditions					
Lbs. of sulphur per plot	**1938* Dry**	**1939* Normal**	**1941† Wet**	**1942† Wet**	**1943† Dry**	**1944† Dry**
500	61.6	83.4	.....	.....	.....	.....
700	39.2	96.0	.....	.....	.....	.....
None	0.	107.4	.....	.....	.....	.....
500	50.4	87.5	.....	.....	.....	.....
700	56.0	131.5	.....	.....	.....	.....
500	48.5	113.0	.....	.....	.....	.....
None	0.	114.3	241.1	171.2	8.1	0.
700	47.0	100.7	.....	.....	.....	.....
700	44.8	110.7	.....	.....	.....	.....
500	187.0	109.0	.....	.....	.....	.....
600	75.2	125.7	217.8	121.0	103.9	182.9
None	2.7	142.0	272.3	121.0	48.4	0.
800	82.0	114.2	163.4	196.6	89.4	220.5
600	103.1	119.9	.....	.....	.....	.....
None	12.0	150.5	278.9	212.4	89.4	5.4
800	102.2	124.7	247.9	171.2	64.5	96.8
600	63.1	150.2	229.8	171.2	64.5	53.8
800	40.4	147.3	.....	.....	.....	.....

*Sulphur applied March 14, 1938.
†Sulphur applied Feb. 17, 1941.

On the farm of J. R. Barry, the disease appeared somewhat later and so the infestation was less general. For the tests, fields were selected on which it was thought that the infestation was fairly uniform. The results of the tests on this farm are presented in Table 4.

TABLE 4.

Effect of Sulphur on Yields of Individual Plots on Farm of J. R. Barry, Grand Coteau, Louisiana. Yields Based on Crates of No. 1 and No. 2 Potatoes per Acre. Sulphur Applied March 16, 1938.

Lbs. of sulphur per plot	Year and Moisture Conditions				
	1938 Dry	1939 Normal	1941 Wet	1943 Dry	1945 Normal
500	99.2	128.6	37.8	136.5	61.9
None	9.9	83.9	57.1	96.8	52.9
700	74.4	69.7	105.8	190.4	79.4
None	3.8	59.5	37.8	132.3	26.5
500	82.2	66.4	45.0	191.6	69.4
700	83.3	136.1	116.1	225.0	82.4
800	140.4	213.4	177.6	140.4	145.2
None	4.5	217.8	205.7	38.7	20.3
600	135.0	204.2	161.2	112.8	141.3
None	49.6	239.8	116.4	169.4	76.8
800	163.8	227.3	149.7	190.2	163.2
600	150.4	220.7	151.3	170.8	100.7

From the results of the yield tests, two facts seem to be definitely established. *First,* soil rot may materially reduce the yield and under certain weather conditions may totally destroy the crop in some fields. *Second,* under weather conditions favorable for the disease, an application of sulphur gives almost complete control of the disease.

Relation to Rainfall

To show more clearly the effect of soil moisture on the development of soil rot, it is interesting to compare the results obtained in dry years and wet years. In the dry years, the rainfall was light in that period in which the young plants were developing their roots and starting growth shortly after being set in the soil, while in the wet years the rainfall was heavy during that period. The average increases in yield obtained from the sulphur treatments in dry and wet years and also in years considered fairly normal from the standpoint of precipitation are presented in Table 5.

The results which were obtained in the so-called dry years, or in those years in which the soil was dry during the period in which the plants were producing their roots and becoming established, were very outstanding. In such years, on many of the unsulphured plots, the loss was total or practically so. Only in those plots in which the infestation of the soil rot organism was apparently restricted, did any of the plants grow and produce potatoes. In the sulphured plots, on the other hand, the yields were satisfactory and as good as or better than the average of those in the fields in the community not affected with soil rot. As shown in Table 5, the sulphur was responsible for an average increase of 78.5 crates per acre, or 235 per cent. In some tests increases of 120 to 160 crates were obtained. In years that were considered normal, an increase of 28.1 crates, or 29 per cent, was obtained. In the wet years, however, the sulphur seemed to have little or no effect.

TABLE 5.

Increases in Yield, Measured in 50-Pound Crates per Acre, Resulting from Sulphur Treatment in Wet, Dry, and Normal Years; All Treatments and Tests Averaged.

Rainfall condition	Average yields in crates per acre		Increases in crates per acre	Per cent increase
	No sulphur	Treated with sulphur		
Dry years	33.4	111.9	78.5	235.0
Normal years	96.9	124.8	28.1	29.0
Wet years	139.6	141.2	1.6	1.2

How Long is Sulphur Effective?

From the standpoint of the grower, it has been important to determine the effectiveness of a single application of sulphur in controlling the soil rot in the succeeding years. If sulphur were only effective in holding the disease in check in the season immediately following its application, its use might not be a practical method of control, owing to the expense involved. If, on the other hand, satisfactory sweet potato crops could be grown in the treated fields for a period of six or eight years, the expense of treatment which might be charged to each crop would be small.

The tests in the last few years of the investigations were conducted to determine the lasting effects of the sulphur. No new applications of sulphur were made and the plots used were those which had been sulphured from 4 to 8 years earlier. The yields obtained in the individual tests in 1944 (a dry year) and 1945 (a normal year), with the number of years after the applications of sulphur, are included in Table 6. Only the plots which received 600 pounds of sulphur are included.

It seems certain that on the terrace soils of St. Landry Parish in Louisiana, applications of 600 to 800 pounds of sulphur will largely eliminate the losses from soil rot for a period of five to six years and possibly longer. While it has not been determined with certainty how long a sulphur application will be effective in controlling the soil rot, it has seemed advisable to recommend a second application of sulphur at the rate of 200 to 300 pounds per acre after five to six years. Such an application seems necessary to hold the pH of the soil close to 5.0.

TABLE 6.

Results Showing the Effectiveness of Sulphur Treatment in the Years Following the Treatment. Yields of Unsulphured Plots and Plots Treated with 600 pounds of Sulphur in Individual Tests in 1944 (Dry Year) and 1945 (Normal Year).

1944			1945		
Crop year after treatment	No sulphur	Treated with sulphur	Crop year after treatment	No sulphur	Treated with sulphur
4	0.0	112.5	5	134.5	153.2
4	1.8	118.4	8	44.1	121.0
5	82.1	204.0	6	168.3	200.7
4	6.7	129.4	5	32.3	107.9
4	18.9	187.2	6	26.1	54.2
6	102.8	188.7			

Effect of Sulphur on Other Crops

While no yields were taken on other crops grown in the sulphured plots, observations were made each year. In dry years, the first season after the sulphur was applied, a slight injury was noticed on corn. No injury was observed after the first year. Cotton and soybeans were not injured in so far as could be determined. Tomatoes and snap beans were severely injured in a dry year in one set of plots.

Summary

The soil rot of sweet potatoes has caused serious losses in certain areas in Louisiana since 1934.

The causal organism, *Actinomyces ipomoea,* does not grow at a pH below 5.2. The terrace soils in St. Landry Parish in which the disease has been troublesome vary from pH 5.6 to 5.8.

By applying sulphur at rates of 500 to 800 pounds per acre, it has been possible to lower the pH of these soils to about 5.0 and to maintain it at that level for from four to six years. The 500-pound application did not seem to be quite as effective as the higher applications.

Losses from soil rot have been practically eliminated by the application of sulphur. In the better fields, increases of 120 to 160 crates per acre from the sulphur treated areas have not been uncommon.

The disease was more severe in years when the rainfall was low at the time the young plants were producing their roots. In dry years in severely infested fields, all plants were killed or failed to make vine growth. In very wet years, losses from soil rot were slight.

Recommendations

Every possible measure should be taken to prevent the disease from being introduced into disease-free fields. This is particularly important in those areas where the pH of the soil is 5.2 or higher.

All possible precautions should be taken against introducing soil from an infested field into a disease-free field by means of plows and various implements.

If the disease is not present on an individual farm, seed or slips from an outside source should not be obtained unless it is known that they come from a source free from the soil rot disease.

Apply sulphur broadcast at the rate of 600 to 700 pounds per acre. The sulphur can be applied during the months of October, November, December, and January, but not later than January and preferably before January if possible.

The sulphur should be disced into the soil as soon after application as possible.

After 5 to 6 years, it will be necessary to resulphur the field with 200 to 300 pounds of sulphur per acre depending on the pH reading of the soil at the end of the 5-year period.

Do not plant any crop other than sweet potatoes the first year after the sulphur is applied to the soil.

Agricultural soil sulphur is just as effective as the finer ground sulphur, is easier to apply by drill, and is the cheapest form of sulphur.

Lime should not be applied to a field in which sweet potatoes are to be planted.

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Louisiana Bulletin No. 409 January 1947

CONSUMER PREFERENCES IN SWEET POTATOES

By

J. M. Baker

Test Display in a Chicago Food Store

LOUISIANA STATE UNIVERSITY
AND
AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
BATON ROUGE, LOUISIANA
W. G. TAGGART, *Director*

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Summary

The survey to determine consumer preferences in sweet potatoes was conducted in five Louisiana cities and in Chicago. Records of purchases in retail stores and interviews with over 3,000 consumers reveal:

1. With U. S. No. 1, U. S. No. 2, and cull sweet potatoes priced, respectively, at the ratio of 7 cents, 5 cents, and 3.5 cents a pound, customers purchased 80.9 per cent U. S. No. 1's, 16.3 per cent U. S. No. 2's, and 2.8 per cent culls. In the tests between U. S. 1's and U. S. 2's, the purchases were about four to one in favor of the former.
2. With U. S. No. 1's divided according to size, that is, the small size weighing up to 7 ounces, the medium size 8 to 12 ounces, and the large size weighing 13 to 24 ounces, and all sizes priced the same, customers purchased 34.7 per cent small size, 49.3 per cent medium size and 16.0 per cent large size.
3. Eighty-five per cent of the customers were housewives, 10 per cent husbands, and 5 per cent children, servants, or friends of the family.
4. The average size of the family was 3.3 persons. The principal consumers of sweet potatoes, according to the reports, are adults.
5. Sweet potatoes are served to the family an average of 2.2 days a week.
6. The average size purchase at the grocery stores was 3.4 pounds.
7. Fifty-five per cent of the customers said they oven-baked the sweet potatoes, 22 per cent candied them, 10 per cent fried them, 6 per cent cooked them with meat, and 7 per cent made them into pies, puddings, and the like.
8. Appearance in the sweet potatoes was very important. Color, shape, size, and smoothness had much to do with the price the consumer was willing to pay and the total amount that was purchased.
9. The use to be made of the sweet potatoes is an important factor in grading for the retail stores. Those too small are inclined to be stringy, and not enough for one serving when baked; those above 12 ounces are somewhat too large for a single serving and require too much cooking time and fuel. The ideal potato for baking is well-shaped and weighs one-half pound. The popular range is from 7 to 12 ounces.
10. Careful grading of sweet potatoes will help maintain a good price and increase consumption. In the long run, it should mean greater returns for the producers.

CONSUMER PREFERENCES IN SWEET POTATOES

By J. M. Baker

Introduction

Commercial production of sweet potatoes has become a major farming enterprise in Louisiana and is growing rapidly. According to the Louisiana State Department of Agriculture, the amount of this product marketed increased from 3,104 carlot equivalents in 1940-41 to 15,031 carlots during the season of 1945-46, an increase of 484 per cent. All of the 1945 commercial sweet potato crop, except about 25 per cent used for processing, moved to the fresh vegetable markets of this and 20 other states. Along with improved varieties and yields, some of the enthusiasm over production no doubt has been due to heavy demand and good prices during the war period. As the country returns to peacetime conditions and orders for the armed forces decline, farmers may have to depend more and more on expanded civilian consumption as an outlet for the increased production.

To increase consumption of sweet potatoes, two basic factors must be kept in mind. One is to get present consumers to purchase more per capita and the other is to enlarge the number and range of consumers. The first step in this direction would be to find out what qualities in sweet potatoes are most desired by the consumers, and follow this with suitable programs of education and advertising. This study is designed, therefore, to obtain from the consumers, first hand, their preferences for the different qualities in sweet potatoes and to compile the information for special use by producers and shippers.

In planning and conducting the study three agencies were especially helpful. The Great Atlantic and Pacific Tea Company provided the sweet potatoes and most of the marketing facilities. Its personnel assisted in working out the schedules for use in the stores; the Louisiana State Market Commission, through the Federal-State inspection service, supervised the grading of the sweet potatoes and helped finance the study conducted in another state; the Horticultural Research Department, and the Home Economics Division of Agricultural Extension Service, Louisiana State University, assisted in the preparation for the survey and in obtaining the data.

The over-all study was divided into three lesser studies. The first of these was conducted in New Orleans during March, 1945; the second was made on a state-wide basis in Louisiana in December, 1945, and included the cities of Alexandria, Baton Rouge, Monroe, New Orleans and Shreveport; and the third study was conducted in Chicago during March, 1946. A total of 19 retail food stores was used.[1] The type and location of the stores were selected to give a good cross-section of the industrial, racial, and purchasing power classification of the consumers. The smaller studies will be referred to in this report as "New Orleans," "State-wide," and "Chicago."

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[1] At Alexandria, two Rush Super Markets and one A & P Store; at New Orleans, three A & P Stores; at Baton Rouge, one H. G. Hill Store and two A & P Stores; at Monroe, two Brice's Super Markets, and Caldwell Bros. and E & P Groceries and Markets (West Monroe); at Shreveport and Chicago, three A & P Stores each.

The general purpose of the project was pursued with three main objectives: (1) to determine the relative amounts of the different grades of sweet potatoes consumers will take at different prices; (2) to test the importance of the size of sweet potatoes in consumer preferences; and (3) to obtain from customers of the retail stores information on the principal buyer for the household, the size of family, frequency of serving sweet potatoes, size of purchases, and the different methods of cooking.

Preferences Based on Grade

The sweet potatoes used in the tests were of the regular commercial grades and of the Porto Rico variety. This part of the study extended over a three-day period, and at New Orleans and Chicago comprised U. S. No. 1 and U. S. No. 2 grades. In the state-wide study, the same grades were used with an additional exhibit of cull sweet potatoes, as shown in Figure 1. At all stores the usual methods of handling this product were followed. Price schedules based on units of one to five pounds were employed in all cases, except during the first study at New Orleans, where the sweet potatoes were priced in two-pound quantities. The schedules, of which a sample appears in the Appendix, were used to eliminate the influence of pricing on the size of individual purchases. The influence of price on consumer choices was measured by lowering the prices of the U. S. No. 2's and the culls successively on the second and third days of the test period. Although the base price from which the schedules were constructed varied from one city, or one store, to another, the grade-price ratios remained practically the same throughout the study.

In most cases, the managers assisted in keeping daily records of purchases, and special assistance was employed to interview customers and compile the desired information. The amount and percentage of the different grades of sweet potatoes purchased by consumers at the different prices are presented in Table 1.

State-wide Study

The state-wide study in Louisiana was somewhat broader in its survey than the studies made at New Orleans and Chicago. In addition to reaching a wide range of consumers in the cities, it included stores patronized also by rural people.

According to the table, the total of 1,580 pounds of sweet potatoes purchased during the first day of the test included 83.6 per cent U. S. No. 1's, 11.5 per cent U. S. No. 2's, and 4.9 per cent culls. The 1,973 pounds taken the second day comprised 81.6 per cent U. S. No. 1's, 17.2 per cent U. S. No. 2's, and 1.0 per cent culls. The 1,394 pounds purchased the third day were 77.5 per cent U. S. No. 1's, 20.3 per cent U. S. No. 2's, and 2.2 per cent culls. The

TABLE 1. AMOUNT AND PERCENTAGE OF DIFFERENT GRADES OF SWEET POTATOES PURCHASED BY CONSUMERS AT RETAIL FOOD STORES, BASED ON GRADE AND PRICE DIFFERENTIALS IN SELECTED CITIES, 1945 AND 1946*

Study and Cities	*Pounds Purchased*	*Average per cent and price per pound, by grades*			
		U. S. No. 1	*U. S. No. 2*	*Culls*	*Total*
State-wide	(First Day)	(7c)	(6c)	(4c)	
Alexandria	505	90.1	9.9	.0	100.0
Baton Rouge	342	78.4	13.2	8.4	100.0
Monroe	256	83.3	11.6	5.1	100.0
Shreveport	477	82.5	11.4	6.1	100.0
All Cities	1,580	83.6	11.5	4.9	100.0
	(Second Day)	(7c)	(5½c)	(3½c)	
Alexandria	460	94.2	5.8	.0	100.0
Baton Rouge	756	80.2	14.9	4.9	100.0
Monroe	415	80.0	20.0	.0	100.0
Shreveport	342	71.8	28.2	.0	100.0
All Cities	1,973	81.6	17.2	1.0	100.0
	(Third Day)	(7c)	(4½c)	(3c)	
Alexandria	425	100.0	.0	.0	100.0
Baton Rouge	487	84.1	13.1	2.8	100.0
Monroe	272	62.1	37.2	.7	100.0
Shreveport	210	64.0	30.8	5.2	100.0
All Cities	1,394	77.5	20.3	2.2	100.0
Above Study	4,947	80.9	16.3	2.8	100.0
Chicago	3,745	80.0	20.0	—	100.0
New Orleans	7,730	79.0	21.0	—	100.0
All Studies	16,422	—	—	—	—

* In New Orleans, the base price per pound for U. S. No. 1 sweet potatoes was 8 cents and for U. S. No. 2's, 7 cents. For the same grades in Chicago, the base price was 10 cents and 8 cents, respectively. For the complete price schedule used in most of the cities in the state-wide study, see Appendix.

averages of all the cities during the period were 80.9 per cent 1's, 16.3 per cent 2's, and 2.8 per cent culls.

The influence of price on consumer preference for the different grades of sweet potatoes also is indicated by the data. As the prices of the lower grades declined during the period, the relative amount of U. S. No. 2's purchased increased from 11.5 per cent to 17.2 per cent, while the amount of U. S. No. 1's taken decreased from 83.6 per cent to 80.9 per cent. The movement of culls reacted very little to change in price. On the average, about 19 per cent of the purchases appear to have been affected by differences in price.

New Orleans Study

At New Orleans, where the first study of consumer preferences was made and cull sweet potatoes were not included, a one-price schedule was used throughout the three-day period, that is, two pounds of U. S. No. 1's for 15 cents and two pounds of U. S. No. 2's for 13 cents. The total purchases in the retail stores during the time were 7,630 pounds, of which 79 per cent were of the U. S. No. 1 grade and 21 per cent U. S. No. 2's.

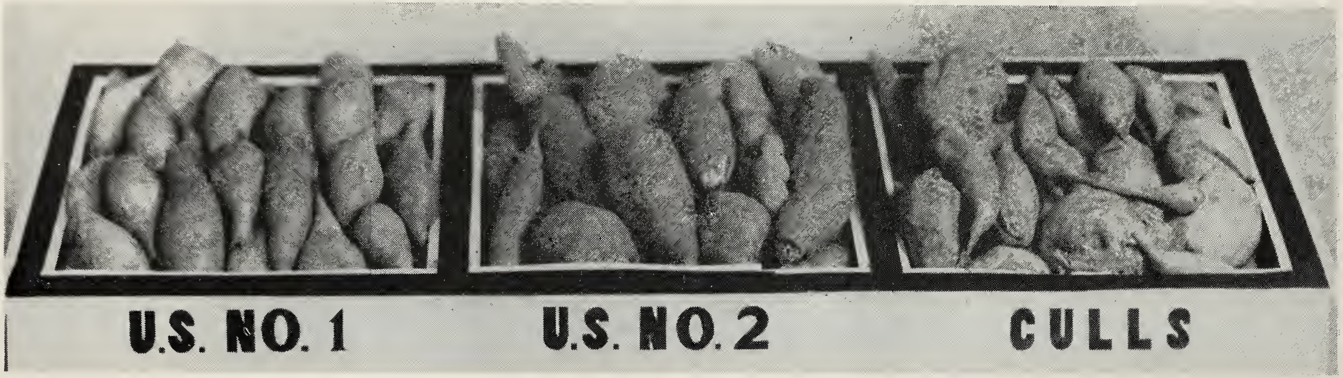


Fig. 1.—Representing Exhibit Used in State-wide Study of Grade Preferences.

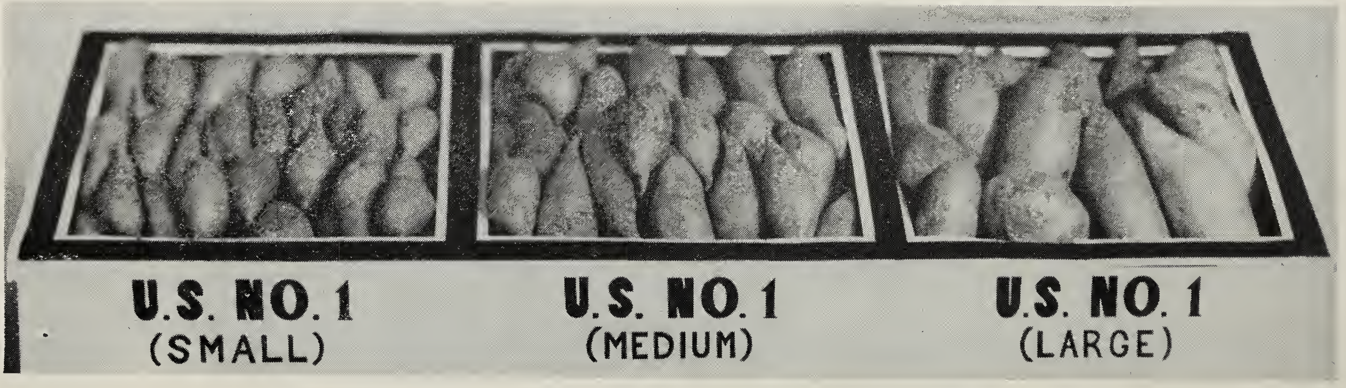


Fig. 2.—Representing Exhibit Used in Sweet Potato Size Preferences.

Chicago Study

At Chicago, where the tests also were with U. S. No. 1 and U. S. No. 2 grades of sweet potatoes, the varying price schedule was used but no day to day records were kept of the purchases. The total of 3,745 pounds taken during the test period in three large and widely distributed food stores represented 80 per cent U. S. No. 1's and 20 per cent U. S. No. 2 grade.

Other Statements and Observations

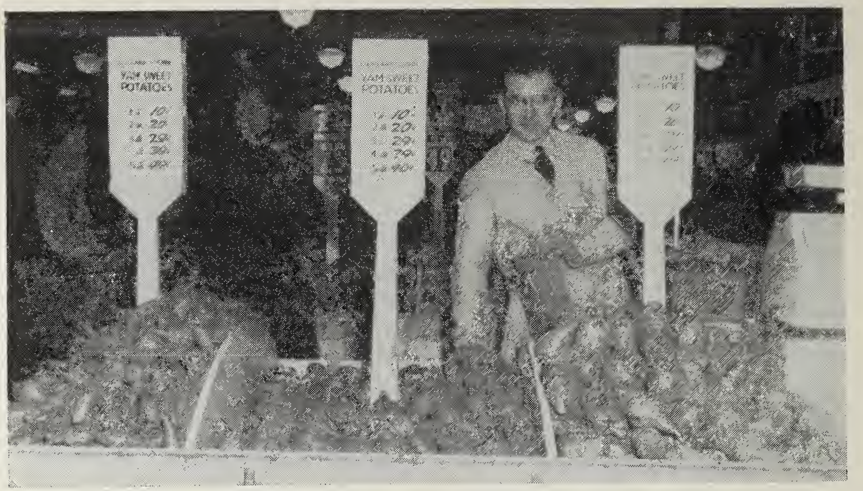
The data examined thus far in the studies of grade preferences in sweet potatoes indicate principally three things: (1) on the basis of display and difference in price, consumers prefer the U. S. No. 1 grade sweet potatoes over the U. S. No. 2's in the ratio of about four to one; (2) under present conditions, price difference is a minor factor in consumer choices; and (3) even at low prices, culls have no place on the fresh sweet potato market.

Some additional information was obtained through interviews with the customers in the stores and from general observation of customer reactions to the different grades of sweet potatoes on display. For example, after a customer had selected the sweet potato bin to "pick" from, she was asked, "Why did you choose that bin?" (No grade labels were attached.) If it was the bin of U. S. No. 1's, she almost invariably would say, "They looked better," and then would explain that those sweet potatoes were better colored and shaped, smoother and of a more uniform size than the ones in the other bins. If she had selected the bin of U. S. No. 2's, the reason usually was the lower price. All who observed carefully the consumers making their choices were impressed by the indicated economic importance of having good quality sweet potatoes accompanied by good appearance, or attractive display. The old adage that "goods well displayed are half sold" has an application to sweet potatoes.

On the side, observations were made in Chicago of shipments of U. S. No. 1 sweet potatoes from Louisiana other than the lot from which the test exhibits were taken. And even though these shipments bore the U. S. No. 1 label, they contained a sufficient amount of broken, misshapen and off-size sweet potatoes to injure the display, slow down the demand, and cause some of the product to be discarded as waste. Producers pay useless and avoidable expenses in attempting to market undesirable and often unsalable sweet potatoes.

Preferences Based on Size

During the first study in New Orleans, in which no size tests were conducted, it was observed that customers in the retail stores selected sweet potatoes considerably from the standpoint of size and uniformity, and that these factors were probably related to specific uses. Consequently, in the two succeeding studies size tests were included.



U. S. No. 1 (small) | U. S. No. 1 (medium) | U. S. No. 1 (large)

Fig. 3.—Picture of Sweet Potato Exhibit in an A & P Food Store in Chicago Indicating Consumer Preference for the Different Sizes.

The sweet potatoes in these studies were divided into three sizes, namely, small, medium, and large. The small size included sweet potatoes ranging from the minimum for the U. S. No. 1 grade to a maximum of 7 ounces in weight; the medium size ranged from 8 to 12 ounces; and the large size from 13 to 24 ounces. The different sizes were priced the same, and displayed side by side, as shown in Figure 2.

The results of the size tests in five Louisiana cities and in Chicago are given in Table 2. As consumers purchased from the exhibits 13,531 pounds of the sweet potatoes they indicated their preferences by taking 34.7 per cent small size, 49.3 per cent medium size, and 16.0 per cent large size.

In their selection of sweet potatoes in the stores, customers explained that size was closely associated with the methods of

TABLE II. Amount and Percentage of Different Sizes of U. S. No. 1 Sweet Potatoes Purchased at Retail Stores in Selected Cities, 1945 and 1946

Cities	Pounds Purchased	*Average per cent of purchases, by size*			
		Small	*Medium*	*Large*	*Total*
Alexandria	1,040	40.7	44.5	14.8	100.0
Baton Rouge	1,031	32.7	56.5	10.8	100.0
Monroe	1,372	42.7	51.8	5.8	100.0
New Orleans	5,960	33.6	43.6	22.8	100.0
Chicago	2,568	20.7	56.7	22.6	100.0
All Cities	13,521	34.7	49.3	16.0	100.0

preparation and cooking. For instance, if used for oven baking, the large size would not cook thoroughly while the rest of the meal was being prepared. If too small, one sweet potato would not be enough for one serving and often was found to be stringy. Extremes were to be avoided. Many of the very small and the very large sizes, especially the latter, were used for casserole dishes, pies and puddings. The most popular size range based on weight, and therefore the ones in greatest demand, were the sweet potatoes weighing from 7 to 12 ounces.

In addition to the waste in the undersized sweet potatoes in the retail stores, those above 15 ounces in weight slow down the sales and affect the total volume of purchases. From a business standpoint, the findings in the size tests should be of special interest to producers, for, the nearer the sweet potatoes offered for sale come to pleasing the consuming public, the greater will be the amount purchased and the better will be the price. It is no doubt unwise to include in shipments to the fresh markets sweet potatoes that may not net expenses and at the same time may even seriously curtail demand. More advantageous outlets should be used.

Members of Household Buying Sweet Potatoes

The number and percentage of the different members of the household purchasing sweet potatoes in the retail stores are shown in Table 3.

Of the 3,032 customers interviewed who purchased sweet potatoes in the five Louisiana cities and in Chicago, an average of 85.3 per cent were wives, 9.8 per cent husbands, and 4.9 per cent children, servants or friends of the family. A few probably represented small restaurants. The relatively wide variations shown among the cities may have been due to difference in type and location of the stores. It is chiefly the housewife with her

TABLE III. NUMBER AND PERCENTAGE OF DIFFERENT MEMBERS OF THE HOUSEHOLD PURCHASING SWEET POTATOES AT RETAIL STORES IN SELECTED CITIES, 1945 AND 1946

Cities	*Number* *Purchasers*	*Average per cent of different purchasers* *Wives*	*Husbands*	*Others**	*Total*
State-wide†					
Alexandria	328	83.5	12.8	3.7	100.0
Baton Rouge	441	89.8	8.4	1.8	100.0
Monroe	239	82.5	14.3	3.7	100.0
New Orleans	1,234	87.5	8.6	3.9	100.0
Shreveport	305	88.9	9.5	1.6	100.0
Chicago	485	80.3	5.0	15.0	100.0
All Cities	3,032	85.3	9.8	4.9	100.0

* Child, servant or friend.
† The separate New Orleans study is included.

preferences, however, who will determine the kind of sweet potatoes best suited to retail trade.

Size of Families Buying Sweet Potatoes

It is important for those who wish to advertise sweet potatoes for human consumption to know whether present or potential consumers are adults or children. This information is presented in Table 4, which represents interviews with over 3,000 consumers in the widely distributed cities.

The data indicate that over one half, or 53.2 per cent, of the families comprised from two to three persons, including parents, and that over three-fourths, or 77.1 per cent, numbered less than five. The average size of family for all the studies was 3.3 persons. The indications therefore are that the principal consumers of fresh sweet potatoes are adults, and that there is probably a large untapped market for this product as an especially good food for children.

TABLE IV. PERCENTAGE OF THE DIFFERENT SIZES OF FAMILIES PURCHASING SWEET POTATOES AT SELECTED RETAIL MARKETS, 1945 AND 1946

Study and Place	*Per cent of families of different sizes*								
	One	*Two*	*Three*	*Four*	*Five*	*Six*	*Seven*	*Eight*	*Total*
State-wide									
Alexandria	2.7	27.6	28.1	18.8	13.8	4.6	2.0	2.0	100.0
Baton Rouge	4.0	36.1	24.7	17.9	1.7	3.5	2.4	2.7	100.0
Monroe	4.0	32.7	30.2	19.8	8.8	1.2	1.7	1.6	100.0
New Orleans	3.1	27.2	23.5	23.2	12.1	7.8	1.6	1.5	100.0
Shreveport	3.3	26.6	23.8	22.2	12.7	3.8	3.9	3.7	100.0
Average	3.7	27.2	25.0	22.2	11.8	5.1	2.7	2.3	100.0
New Orleans	4.4	24.3	26.0	20.0	12.1	7.9	3.6	1.7	100.0
Chicago	6.8	34.2	23.1	14.5	11.1	6.0	2.6	1.7	100.0
Average of Studies	5.0	28.5	24.7	18.9	11.7	6.3	3.0	1.9	100.0

NOTE—Average size of family including parents: New Orleans, 3.6 persons; Louisiana state-wide, 3.5; and Chicago, 2.7. Average of all cities, 3.3 persons.

Frequency of Serving Sweet Potatoes

The frequency with which sweet potatoes are served to 2,358 families in five Louisiana cities is indicated in Table 5. Of the families represented at 15 stores of these cities, 67.9 per cent are served sweet potatoes an average of from one to two days a week. The customers as a whole serve their households this food an average of 2.2 days a week.

Size of Individual Purchases

A knowledge of the average size purchase of sweet potatoes at the retail stores should be valuable to store operators in calculating quantity-price quotations, and to producers in packaging

TABLE V. NUMBER OF DAYS A WEEK SWEET POTATOES ARE SERVED TO FAMILIES, AS REPORTED BY CUSTOMERS AT 15 RETAIL STORES IN SELECTED CITIES, MARCH AND DECEMBER, 1945

City	Customers Reporting	Days a week served to family					Average Days Served
		One	Two	Three	Four-up	Total	
	Number	*Per cent of families reported*					*Number*
Alexandria	298	24.2	40.6	17.8	17.4	100.0	2.3
Baton Rouge	415	21.4	36.9	18.8	22.9	100.0	2.4
Monroe	228	26.3	43.3	18.0	12.3	100.0	2.2
New Orleans	1,142	38.5	37.7	14.1	10.4	100.0	2.0
Shreveport	275	15.3	37.1	25.1	22.5	100.0	2.5
All Cities	2,358	29.8	38.1	17.0	15.1	100.0	2.2

sweet potatoes for the retail trade. A report from over 2,000 retail store customers indicating the percentages of different sizes of purchase of sweet potatoes by grade and by size is presented in Table 6.

Of the individual purchases of from one to six pounds and above, about 55 per cent were in two- and three-pound quantities. The largest average-size purchase was 4.1 pounds of the U. S. No. 1 small size. The average for all the sizes combined was 3.4 pounds.

TABLE VI. PERCENTAGE OF DIFFERENT SIZES OF INDIVIDUAL PURCHASES OF SWEET POTATOES AT RETAIL STORES IN SELECTED CITIES, 1945 AND 1946

Size of Purchase	Studies						
	New Orleans*	La. State-wide				Chicago	All
	Reg.†	Reg.	Small	Medium	Large	Reg	
1 pound	10.0	4.1	7.5	5.7	1.4	3.4	4.4
2 pounds	41.2	20.8	30.4	20.4	13.7	41.6	25.4
3 pounds	12.6	29.3	27.8	29.7	24.7	37.1	29.7
4 pounds	26.0	12.3	17.0	17.7	12.3	12.4	15.6
5 pounds	6.0	18.0	12.1	15.3	27.4	4.4	15.4
6 pounds and up	4.2	9.3	5.3	11.5	20.5	1.1	9.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	Pounds						
Average	3.0	3.5	4.1	3.5	3.1	2.8	3.4

* New Orleans not used in "All" because of different pricing methods.
† Regular U. S. No. 1 and U. S. No. 2 sweet potatoes.

Methods of Cooking Sweet Potatoes

All consumer preferences for sweet potatoes at the retail food stores are based on the use to be made of the selection. Housewives, who are the principal customers, prepare the product in some special and popular way for the family. The number of times each method of cooking sweet potatoes was given by the customers at the stores is shown in Table 7.

TABLE VII. METHODS OF COOKING SWEET POTATOES AS REPORTED BY CONSUMERS AT RETAIL FOOD STORES IN SELECTED CITIES, 1945 AND 1946

	Times different methods of cooking were reported						
	All Methods	*Oven Bake*	*Candy*	*Fry*	*With Meat*	*Other**	*Total*
	Number	*Per cent*					
Alexandria	471	55.2	22.1	7.0	10.2	5.5	100.0
Baton Rouge	655	56.4	17.5	16.5	6.6	3.0	100.0
Monroe	400	51.0	25.2	10.0	4.8	9.0	100.0
New Orleans	2,071	46.1	20.9	15.3	10.4	7.3	100.0
Shreveport	474	53.8	24.3	8.6	3.8	9.5	100.0
Chicago	485	65.0	22.0	5.5	—	7.5	100.0
All	4,554	54.6	22.0	10.5	6.0	6.9	100.0

* Such as puddings and pies.

In the study in five Louisiana cities and in Chicago methods of cooking sweet potatoes were mentioned 4,554 times. Of these, oven-baking was recorded 54.6 per cent of the times, candying 22.0 per cent, frying 10.5 per cent, cooking with meat 6.0 per cent, and other methods, such as making them into pies and puddings, 6.9 per cent. In Chicago, as well as in Louisiana, people seem partial to oven-baked sweet potatoes; hence the decided preference for the medium size.

The preparation of sweet potatoes by candying may increase with the return of a normal supply of sugar. The data indicate that consumers in Louisiana prepare sweet potatoes in more different ways than the people of Chicago.

Appendix

ONE OF THE PRICE SCHEDULES USED IN SWEET POTATO GRADE AND SIZE TESTS*

U. S. No. 1		*U. S. No. 2*		*Culls*	
		First Day			
Purchase	*Cents*	*Purchase*	*Cents*	*Purchase*	*Cents*
1 lb.	7	1 lb.	6	1 lb.	4
2 lbs.	13	2 lbs.	11	2 lbs.	7
3 lbs.	20	3 lbs.	17	3 lbs.	11
4 lbs.	26	4 lbs.	22	4 lbs.	14
5 lbs.	33	5 lbs.	28	5 lbs.	18
		Second Day			
1 lb.	7	1 lb.	5½	1 lb.	3½
2 lbs.	13	2 lbs.	10	2 lbs.	6
3 lbs.	20	3 lbs.	15	3 lbs.	9
4 lbs.	26	4 lbs.	20	4 lbs.	12
5 lbs.	33	5 lbs.	25	5 lbs.	15
		Third Day			
1 lb.	7	1 lb.	4½	1 lb.	3
2 lbs.	13	2 lbs.	8	2 lbs.	5
3 lbs.	20	3 lbs.	12	3 lbs.	8
4 lbs.	26	4 lbs.	16	4 lbs.	10
5 lbs.	33	5 lbs.	20	5 lbs.	13
U. S. No. 1 (Small)		*U. S. No. 1 (Medium)*		*U. S. No. 1 (Large)*	
1 lb.	7	1 lb..	7	1 lb.	7
2 lbs.	13	2 lbs.	13	2 lbs.	13
3 lbs.	20	3 lbs.	20	3 lbs.	20
4 lbs.	26	4 lbs.	26	4 lbs.	26
5 lbs.	33	5 lbs.	33	5 lbs.	33

* Although different price schedules were used for different cities and stores, the grade-price ranges and relations were about the same.

Acknowledgments

In addition to the staff members of the L. S. U. Agricultural Experiment Station, the author wishes to express his appreciation to the many other persons too numerous to mention in this space who made important contributions to this study. They include Messrs. Roy Sellers, R. V. Backstrom, J. C. Peregoy, W. W. Johnson, J. P. Smith, J. C. Brennan and others of the personnel of A & P Tea Company and its food stores; the managers and assistants of H. G. Hill store in Baton Rouge, Rush Super Markets in Alexandria, Brice's Super Markets in Monroe, and Caldwell Bros. and E & P Groceries and Markets in West Monroe; Miss Ellen LeNoir, State Home Demonstration Agent, and her associates; Mr. W. W. Roberts, Executive Secretary of Louisiana State Market Commission, and members of his staff, including the federal-state inspection service; and Mr. P. T. Ecton of Warriner Products Company.

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CONTROLLING ALLIGATOR WEED IN SUGARCANE WITH 2,4-D

By

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CONTROLLING ALLIGATOR WEED IN SUGARCANE WITH 2,4-D

Clair A. Brown and Quintin L. Holdeman

The discovery that certain growth regulating substances, particularly 2,4-D (2, 4-dichlorophenoxyacetic acid) and its derivatives, are toxic and will under some conditions kill weeds has been an outstanding contribution to agriculture. The successful control of weeds makes it possible to raise normal crops, to obtain better yields in weed-infested fields, and in some cases to bring back into cultivation valuable land which has been out of cultivation.

At present, there are over fifty brands of 2,4-D on the market in at least ten formulations. All of these are toxic to many weeds, though some may be more effective in killing specific weeds than others. In general, these compounds do not injure true grasses. This differential killing makes it possible to blanket spray sugarcane fields for the control of alligator weed without serious injury to the cane.

During 1946, large-scale spraying tests with 2,4-D compounds were made on the properties of Mr. B. Thibaut near Napoleonville and Messrs. F. L. Price, Morris Tregre and L. Levert near Thibodaux, and a 2,4-D dust was applied by airplane on Albania Plantation. Some 60 acres of sugarcane were treated with dilute sprays and about 15 acres were dusted with 2,4-D dusts either with a power row-crop duster or by airplane. The objective in these tests was to determine the toxic effect of the various formulations of 2,4-D on alligator weed and to see what effect killing the alligator weed might have on the yield of sugarcane.

The following formulations were used as dilute sprays on alligator weed: the acid plus soda ash, sodium salt, ammonium salt, triethanolamine, copper salt, methyl, ethyl, and butyl esters. For the larger tests these were mixed to a concentration of 1,000 or 2,000 parts per million and applied at the rate of approximately 100 gallons of solution per acre. Small plots were also treated at the following rates: 10, 100, 500, 1,000, 2,000 and 5,000 parts per million (ppm) for certain formulations. The dusts were mixtures of the acid plus soda ash with talc as a carrier, or sodium salt and methyl ester in other carriers. These varied from 2½ to 23 per cent 2,4-D acid content and were applied at 6, 10, 14 and 16 pounds per acre.

Effect of 2,4-D on Alligator Weed

The effect of 2,4-D compounds on alligator weeds can be noticed in about two hours after application. At first there is a slight wilting of the foliage followed by a pronounced wilting and then slumping of the stems. In rapidly growing plants, the development of the stem tips and young leaves is checked and they become slightly yellow. Usually 4 to 6 days after treatment, the stems and leaves turn a brilliant yellow. The stem tips fail to elongate, the nodes swell and become brittle. Finally the leaves drop off and the stems gradually break apart at the nodes. In three to four weeks after spraying, most of the stems will have separated and dried out so that it is difficult to find alligator weeds in the sprayed fields. It must be stressed that the action of 2,4-D is slow. At least 2 to 4 weeks must be allowed to elapse before determining the amount of surface kill and 6 to 10 months for determining the destructive effect upon the root system.

One of the remarkable effects of these sprays is that 8 to 12 weeks elapse before there is an appreciable regrowth of the alligator weed, providing the proper concentration has been used. At 10 ppm very little injury to alligator weed occurs. At 100 ppm the stems become leafless but the plants are seldom killed; the flower clusters are able to develop parthenocarpic fruits and parthenogenic seed-like structures in abundance. At 500 ppm the leaves and many stems are killed. There are fewer fruits produced at this concentration than at 100 ppm. At 1,000

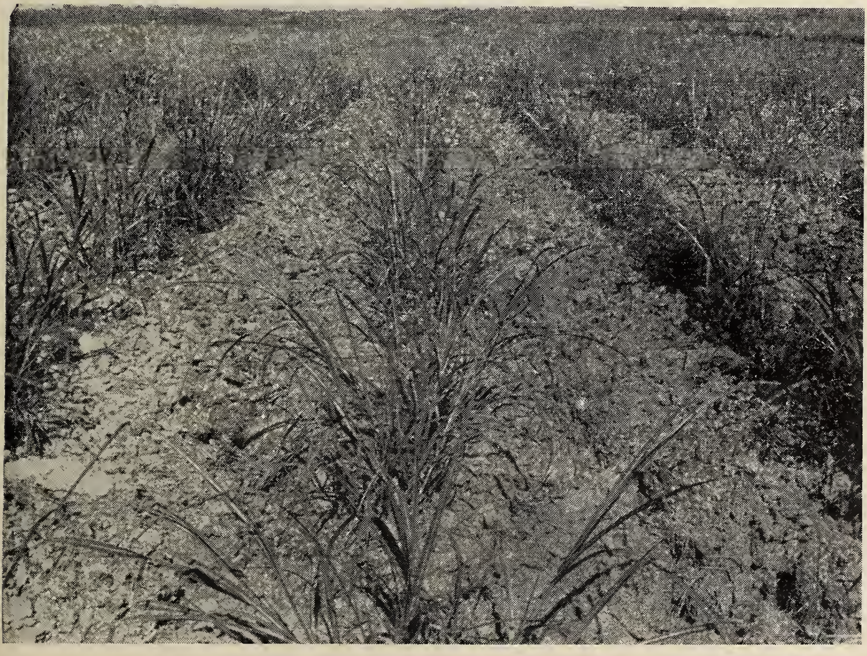

FIGURE 1. Showing the Small Amount of Alligator Weed in 1946, in a Row Sprayed in 1945 with 2,4 Dow Weed Killer at a Concentration of 2,000 ppm at the Rate of 100 Gallons per Acre. The Row on the Right Was Not Treated.

ppm a good kill of the aerial parts was secured, and the quantity of fruits was much less than at the 500 ppm level. The important difference between the 1,000 and 2,000 ppm applications was in the greater delay of the regrowth at the higher concentration.

Observations on the plots treated in 1945 were made in 1946 and it was found that a considerable reduction of the alligator weed took place on the plots treated with a spray solution containing 2,000 ppm of the acid (Figure 1). As a result, many of the 1946 treatments were at this concentration. The complete results on the 1946 treatments will not be available until the spring of 1947.

Effect of 2,4-D on Sugarcane

Sugarcane can be injured with 2,4-D compounds, and some formulations are apparently more toxic to the cane than others. Sprays of the esters at 5,000 ppm into the spindle of sugarcane 18 inches tall produced conspicuous white chlorotic blotches (Figure 2), whereas at 2,000 ppm there was only slight injury. In one series of treatments 2,4-D was applied to cane four days after flame cultivation. Here the cane produced abnormal nodes (Figure 3), which were more abundant on the plants treated with the ethyl and butyl esters at 2,000 ppm than at 1,000 ppm. These injuries were not noted on the sodium salt plots. They were not found in the non-flamed plots that had received the ethyl ester at 1,800 ppm. These concentrations had no depressing influence upon the sucrose and purity. The treated plots had an increase in yield of 1.9 to 4.1 tons per acre over the checks, which indicated that the injuries to the growing cane were slight. It is not known with certainty whether the cane with these abnormal nodes may be satisfactory for field planting.

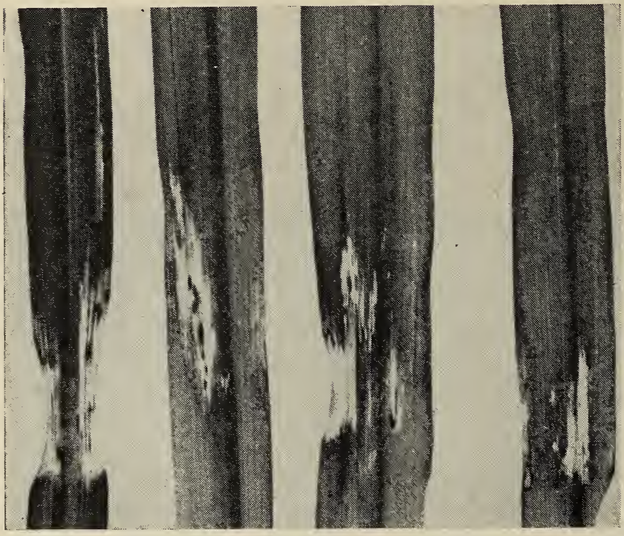

FIGURE 2. Chlorotic Lesions that Developed after Spraying the 2,4-D Esters into the Spindle of the Cane Plant at Concentrations of 5,000 ppm.

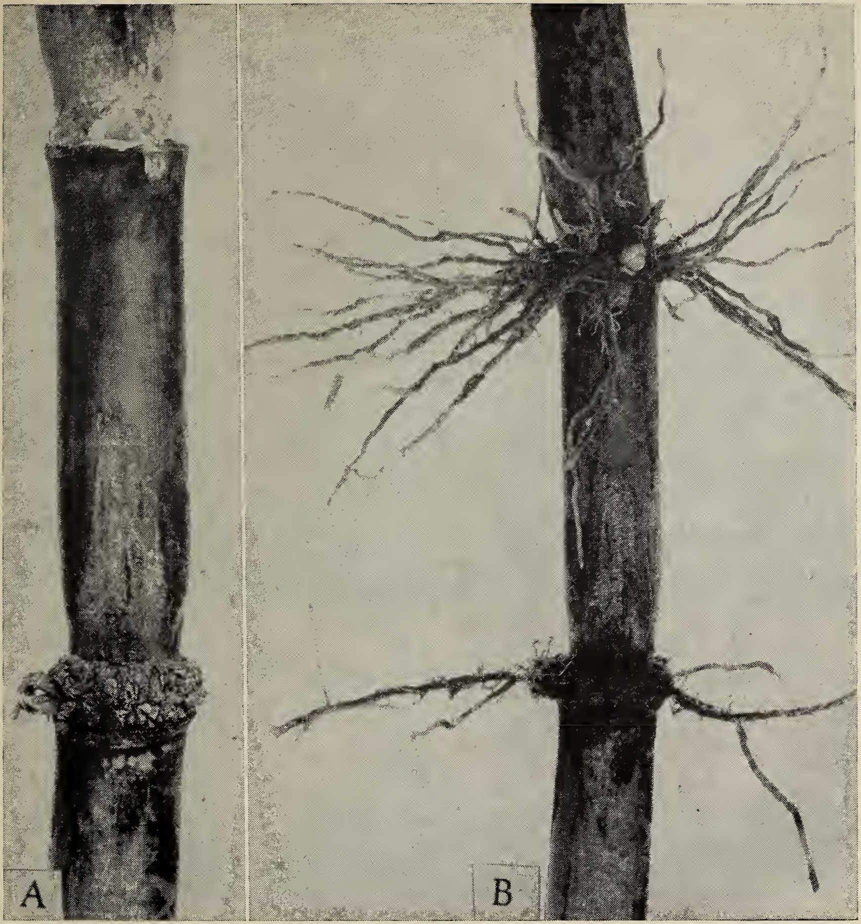

Figure 3. *A*. Type of Injury Developing on Cane where Spraying with 2,4-D Esters Followed Flame Cultivation. There Was an Abnormal Development of the Root Band in the Lower 2 to 4 Nodes, as Well as Shrinkage and Death of Tissue above the Root Band. *B*. Same Stalk as in *A*, 20 Days after Planting. The Reduction in Roots from the Abnormal Nodes May Be Serious.

Yield Data

Tables 1, 2, and 3 give the pertinent data on the plots harvested. These plots were selected because of a reasonably uniform infestation of alligator weed (Figure 4), which varied from moderately dense to very dense at time of spraying. Aside from the spraying, all plots received the usual plantation system of cultivation as far as weather permitted.

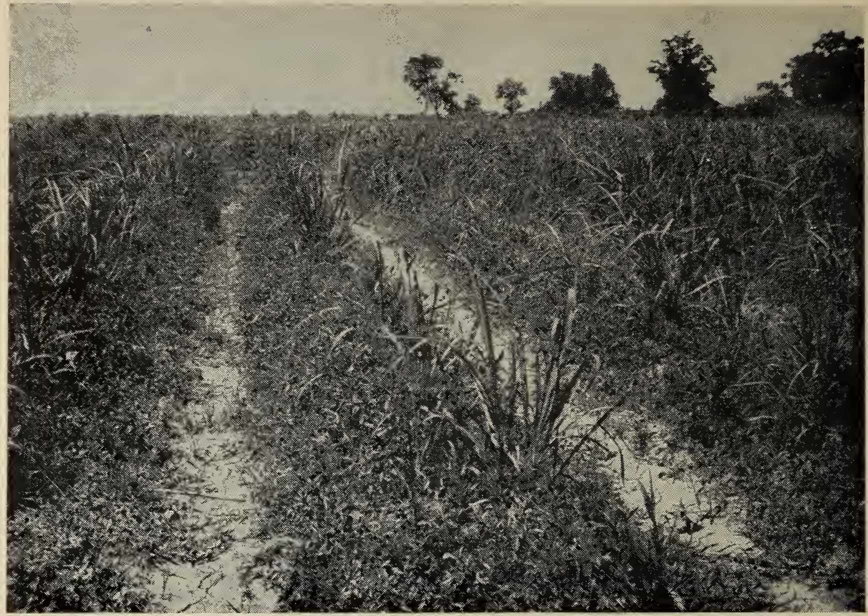

Figure 4. A View Showing the Density of Alligator Weed in Sugarcane Prior to Spraying. An Increase of Three Tons per Acre Was Obtained by Treatment of This Field.

TABLE 1. Comparative Yields, in Tons Per Acre, of 2,4-D Treated and Untreated Plots of Sugarcane, Variety C. P. 34/120, in 1946, on Plantation of F. L. Price, Thibodaux, Louisiana. (Plant Cane.)

Plot	*Compound tested*	*Concentration, in ppm*	*Area of plot, in acres*	*Yield, in tons per acre*	*Difference, in tons per acre*
1	SL-23	1,750	.5	16.3	+6.2
2	No treatment		.2	10.1	
3	Weedone	1,000	.7	17.6	+3.7
4	No treatment		.1	13.9	
5	Ethyl ester of 2,4-D	1,875	.9	13.8	+3.4
6	No treatment		.2	10.4	
7	Tufor 40	1,000	.9	12.2	—1.3
8	No treatment		.2	13.5	

TABLE 2. COMPARATIVE YIELDS, IN TONS PER ACRE, OF 2,4-D TREATED AND UNTREATED PLOTS OF SUGARCANE, VARIETY C. P. 29/120, IN 1946, ON PLANTATION OF M. TREGRE, THIBODAUX, LOUISIANA. (1ST YEAR STUBBLE.)

Plot	*Compound tested*	*Concentration, in ppm*	*Area of plot, in acres*	*Yield, in tons per acre*	*Difference, in tons per acre*
1	SL-23	1,750	1.6	21.7	+4.1
2	No treatment		1.2	17.6	
3	Ethyl ester of 2,4-D	2,000	1.0	20.7	+3.1
4	No treatment		.9	17.6	
5	Ethyl ester of 2,4-D	1,000	1.5	21.4	+3.3
6	No treatment		.5	18.1	
7	Butyl ester of 2,4-D	2,000	1.2	19.5	+1.9
4	No treatment		.9	17.6	
9	Butyl ester of 2,4-D	1,000	1.1	20.6	+2.5
6	No treatment		.5	18.1	

The growth habit of alligator weed is such that it is not possible to evaluate the results of spraying in terms of percentage of plants killed. The evaluation has been based largely on the rapidity and visible amount of regrowth. As far as can be determined, there is no significant difference in the ability of the 2,4-D compounds tested to kill alligator weed when used at the same acid content and volume per acre. The esters may be a trifle quicker in their killing action than the salts. Regrowth occurred in the following order: the amine salt, sodium salt, and then the esters. The slight apparent advantage of the esters from the toxicity standpoint is more than offset by their higher per acre cost. It has been observed that the differences in the kill in spraying tests depend more on the operators holding the spray gun than on the various formulations.

The increases in yield obtained from 2,4-D applications (Tables 1, 2, 3) show that weed spraying can be profitably adopted in the culture of sugarcane. At the present prices of sugarcane, a two-ton increase per acre on 50 acres will pay for the sprayer in one season, as well as the chemicals used and the labor for spraying.

Abnormal weather during part of the 1946 growing season has been blamed for the reduction in yield of cane in the state and in particular for certain varieties.

A superficial examination of the yield data may give the impression that certain formulations are better than others, but this is questionable. Unusually low yields on a control plot can make the yields for the treated plot appear very favorable. Part of the differences between the yields of the controls and sprayed plots can be attributed to the difference in the original stand of cane prior to spraying. The fields were chosen for uniformity of weed infestation and not for uniformity of stand of cane.

TABLE 3. Comparative Yields, in Tons Per Acre, of 2,4-D Treated and Untreated Plots of Sugarcane in 1946, on Plantation of L. Levert, Thibodaux, Louisiana.

Plot	*Variety & type*	*Compound tested*	*Concentration, in ppm*	*Area of plot, in acres*	*Yield, in tons per acre*	*Difference, in tons per acre*
1	C.P. 29/116, 2nd year stubble	Ethyl ester of 2,4-D	2,000	1.7	13.4	+1.2
2		No treatment		.5	12.2	
3	C.P. 29/103, Plant cane	Ethyl ester of 2,4-D	1,000	1.7	14.3	+2.4
4		No treatment		.8	11.9	
5	C.P. 29/116, 2nd year stubble	Butyl ester of 2,4-D	2,000	1.8	16.8	—0.4
6		No treatment		1.3	17.2	
7	C.P. 29/120, Plant cane	Dow A510	2,000	1.5	10.3	—2.3
8		No treatment		.3	12.6	
9	C.P. 29/120, Plant cane	Dow A510	1,500	1.5	8.3	—1.2
10		No treatment		.5	9.5	
11	C.P. 29/116, 2nd year stubble	Dow A510	1,000	1.5	16.8	+3.0
12		No treatment		.3	13.3	
13	C.P. 29/120, Plant cane	Dow A510	1,000	1.5	9.6	+0.1
14		No treatment		.5	9.5	
15	C.P. 29/120, Plant cane	Dow A510 + Tergitol	1,000	1.4	11.0	+0.2
16		No treatment		.6	10.8	

Attention should be directed to the results on plots 7, 9, 13 and 15 (Table 3). The quality of the cane in these cuts was poor, as is indicated by the calculated tonnage of the controls, 9 to 12 tons per acre. A heavy rain followed spraying within four hours. The surface kill of the alligator weed varied from fair to poor, depending on the time which elapsed between spraying and the rain. The lack of any outstanding increase cannot be attributed to depressing effect of the particular chemical used inasmuch as the day before it gave a satisfactory increase on a different variety.

There is no information at present on the relative tolerance of the different cane varieties to 2,4-D. Some attention should be paid to this, as it was shown at the Third Annual North Central States Weed Control Conference held at Des Moines, Iowa, recently, that different genetical lines of corn and strawberries varied in their tolerance to 2,4-D.

Time to Apply

The best killing action of 2,4-D usually occurs when the weeds are making a rapid growth, and for most spring and summer weeds this occurs when the temperature is above 60°F. The killing action is retarded at lower temperatures.

In the tests in 1946, all treatments were integrated with the usual farm practices. About ten days to two weeks after the fertilizer was covered, the rows usually had a good growth of alligator weed. The weeds were from 3 to 8 inches tall. Areas sprayed the middle of April were relatively free of alligator weed in October. Fields treated May 1 had so little regrowth by July 1 that it did not seem worth-while at that time to attempt a second spraying. By August 1, there was enough regrowth to justify a second spraying. In the next two months the growth of the sugarcane so shaded the rows, even in non-treated controls, that only traces of alligator weed could be found in October. Fields treated June 1 remained relatively free of alligator weed into October. Sugarcane makes such a height growth between the middle of June and July 1 that it becomes too tall for tractors and spray equipment, and thus cane is "laid-by" at this time. The results indicate that only one spraying is necessary between May and "lay-by" time. If sprayed in early April and a second spray seems advisable, it will be possible to spray again before "lay-by" time.

In our experiments the middles and the ridges were sprayed uniformly. Some growers sprayed only the ridges, with the concept that cultivation would control the alligator weed in the middles. Actually, plowing out the middles throws the untreated roots upon the ridge, and thus the effectiveness of the spraying is reduced. The fact that alligator weed becomes such a pest in the fields demonstrates that the usual cultivation practices do not control it. Thus spraying the ridge only is a half-way measure of control.

Experiments have shown that a better kill will be obtained if the land is not worked for a week or ten days after the spraying. This allows time for the toxic principle to reach the root system.

Concentration and Volume Per Acre

For the best results, it is necessary to completely wet the plants and have a minimum runoff of the spray solution. Experiments in the past show that good wetting of the foliage was obtained at the rate of 100 gallons per acre for average size plants; less solution is needed for very small plants and more for very rank growths. Water is a carrier to make possible the even distribution of a small quantity of chemical. The volume of water is not as important as the quantity of 2,4-D per acre.

The standard recommendation has been expressed as 1,000 parts of 2,4-D per million (ppm) of the diluting substance, which is usually water. This is a 0.1 per cent solution, or expressed in terms of pounds per acre, it represents one pound of an 80 per cent 2,4-D per acre or 1¼ pounds of a 70 per cent 2,4-D formulation per acre. The best kill of alligator weed in sugarcane was obtained at double the standard strength, or at a concentration of 2,000 ppm with 100 gallons applied per acre. This is equal to 2 pounds of 80 per cent and 2½ pounds of 70 per cent per acre. Table 4 shows the amount of chemical necessary to obtain concentrations of 1,000 ppm and 2,000 ppm at a volume of 100 gallons per acre.

TABLE 4. AMOUNTS OF HERBICIDES TO BE USED PER ACRE IN MIXING SPRAY SOLUTIONS WITH VARIOUS PERCENTAGES OF 2,4-D ACID IN HERBICIDE.

Per cent 2,4-D acid content of herbicide	*Amount of herbicide to give 1,000 ppm per 100 gallons*	*Amount of herbicide to give 2,000 ppm per 100 gallons*
90	14 oz.	1 lb. 12 oz.
85	15 oz.	1 lb. 14 oz.
80	1 lb.	2 lbs.
70	1 lb. 3 oz.	2 lbs. 6 oz.
60	1 lb. 6 oz.	2 lbs. 12 oz.
40*	1 quart	2 quarts
20*	2 quarts	4 quarts
10*	1 gallon	2 gallons

*Usually sold in liquid solutions. See manufacturers' recommendations.

Equipment

In order to apply 100 gallons per acre, the following factors must be integrated: speed of tractor, pump pressure, number of nozzles, and size of the discharge disk. The sprayer used in 1946 has a 125-gallon tank and 18 nozzles on a boom 18 feet long (Figure 5). Because the regulator could not be set for a lower pressure, the number 3 discharge disks were used with a pump pressure of 150 pounds and the equipment was pulled through the field at approximately three miles per hour. The pump had a 7-11 gallons per minute capacity. The acreage covered with one tankful varied from 1.0 to 1.8 acres, with a consistent average coverage of 1.4 acres for many tests.

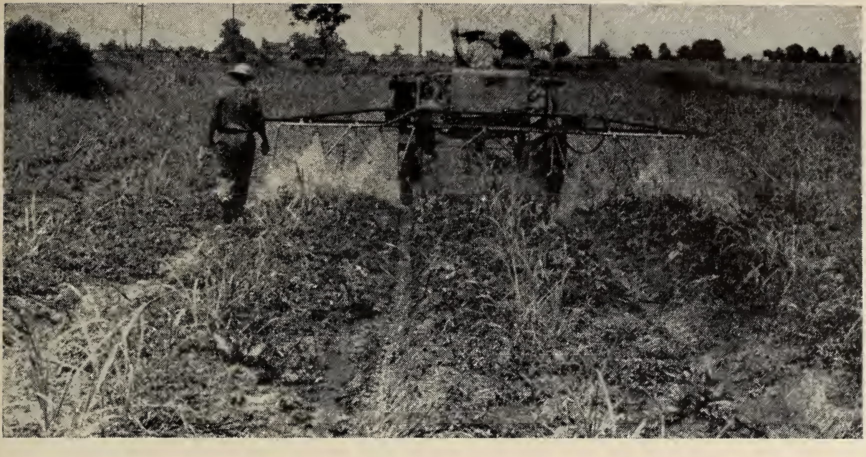

FIGURE 5. Sprayer Used in the 1946 Experiments.

Pressures of 200 to 300 pounds are higher than needed for spraying herbicides at the standard rate of 100 gallons per acre. These pressures tend to mat the vegetation and the solution is atomized so finely that moderate winds cause considerable drift, which should be avoided. Pressures below 50 pounds are generally not as satisfactory as those between 75 and 150.

The capacity of the pump is important because the volume that can be delivered determines the number of nozzles of a given aperture that can be used on a spray boom. The pump on the above machine gave an adequate volume for 18 nozzles with number 3 disks at 150 pounds pressure, or a total of 6.5 gallons per minute. Because of the insufficient pump capacity, there was not a good breaking spray when 18 larger nozzles requiring 18.0 gallons per minute were used.

The pressure can be obtained by means of the usual 2 and 3 plunger type pumps, by air compressors, gear pumps or rotary pumps. At Albania Plantation an air compressor was mounted on the tractor to run off the fan belt. It gave 50 pounds pressure on the spray solution. One company in California is making spray equipment which uses the air compressor system and no spray solution passes through the moving parts of the pump. The capacity of the air compressor is measured in cubic feet of air per minute. If the discharge from the air compressor is placed in the bottom of the solution tank, the escaping air will keep the solution agitated, which is helpful with some of the formulations.

Bronze gear pumps of adequate capacity can likewise be used on the fan belt or run from the side power take-off unit. The surplus solution can be by-passed back to the tank to give agitation.

At least two companies make equipment using a rotary type pump. One of these, which is manufactured for fighting forest fires, has been used for spraying herbicides.

Most of the commercial sprayers have the spray boom on the back of the spray tank. The mounting of the spray boom in front of the tractor is desirable because it will then be in sight of the tractor operator, which will eliminate the necessity of an additional man on the spray equipment.

It is possible to cover three rows at a time with a boom 18 feet long. Several tried to speed up the spraying by extending the boom to cover 5 rows. It was found that a boom this long was unwieldly and on uneven ground or at quarter drains the end of the boom dragged on the ground and breakage resulted. It is suggested that a greater acreage can be covered in a day by using a 3-row boom and by increasing the speed of the tractor, at the same time taking precautions to get out an adequate amount of 2,4-D per acre.

Various power machines for applying dusts are on the market. Many of these can be attached to a tractor, while some are operated by a separate motor. A power duster in a cane cart will save considerable time in attaching and detaching from the tractor if dusting is done for only a few hours a day while the dew is present or until the wind picks up.

The common types of spray nozzles give either a hollow cone or a flat fan-shaped spread of the spray solutions. Many workers report the fan-shaped nozzles give better results for herbicides. Tables 5, 6, and 7 show

TABLE 5. Capacity, in Gallons Per Minute Per Nozzle at Different Pressures, of Majestic Hollow-Cone Nozzles Manufactured by John Bean Manufacturing Co., Lansing, Mich.

Disc No.	*Orifice size, in inches in*		*Capacity, in gallons per minute per nozzle at pressures per square inch of*					
	fractions	*decimals*	*50 lbs.*	*75 lbs.*	*100 lbs.*	*150 lbs.*	*200 lbs.*	*300 lbs.*
2½	5/128	.039	.18	.22	.25	.31	.36	.45
3	3/64	.045	.22	.25	.30	.36	.43	.53
4	1/16	.062	.32	.39	.44	.55	.63	.78
5	5/64	.075	.41	.50	.58	.71	.83	1.02

TABLE 6. Capacity, in Gallons Per Minute Per Nozzle at Various Pressures, of Fan-Type Nozzles Manufactured by Monarch Manufacturing Works, 3303 Salmon St., Philadelphia, Pennsylvania.

Nozzle No.	*Orifice size, in inches*	*Capacity, in gallons per minute per nozzle at pressures per square inch of*					
		50 lbs.	*75 lbs.*	*100 lbs.*	*150 lbs.*	*200 lbs.*	*300 lbs.*
59	.059	.7	.87	1.00	1.20	1.40	1.70
78	.078	1.0	1.30	1.50	1.80	2.10	2.60

the capacities in gallons per minute of both the hollow cone and fan-shaped types of nozzles at different orifice sizes and pressures. It should be noted that different nozzles with the same orifice size and pressure have different capacities.

TABLE 7. CAPACITY, IN GALLONS PER MINUTE PER NOZZLE AT VARIOUS PRESSURES, OF FLAT ATOMIZING NOZZLES MANUFACTURED BY SPRAYING SYSTEMS COMPANY, 4021 WEST LAKE STREET, CHICAGO, ILLINOIS.

Nozzle No.	*Orifice size, in inches in*		*Capacity, in gallons per minute per nozzle at pressures per square inch of*					
	fractions	*decimals*	*50 lbs.*	*75 lbs.*	*100 lbs.*	*150 lbs.*	*200 lbs.*	*300 lbs.*
1/4T8004	3/64	.045	.44	.54	.63	.77	.89	1.10
1/4T8006	1/16	.062	.66	.80	.94	1.20	1.32	1.53

TABLE 8. NUMBER OF MINUTES TO COVER ONE ACRE OF LAND AT VARIOUS SPEEDS PER HOUR WITH 3-ROW AND 5-ROW SPRAY RIGS.

Number of minutes to cover an acre at speeds of						
2 miles hour	2½ miles hour	3 miles hour	3½ miles hour	4 miles hour	4½ miles hour	5 miles hour
With 3-row machine (18' coverage)						
13.8	11.0	9.2	7.9	6.9	6.1	5.5
With 5-row machine (30' coverage)						
8.3	6.6	5.5	4.7	4.1	3.7	3.3

In order to calculate the number of gallons discharged per acre with a spray rig it is necessary to know the speed at which the machine is traveling, the width covered by the boom, the number of nozzles on the boom, and the rate of discharge per minute of the nozzles used. Since nearly all cane rows in the state are six feet wide, the length of time that it would take a spray rig to cover an acre would depend on the speed that the rig was traveling and the number of rows it sprayed at one time. Probably nearly all the spray rigs in the cane area will be designed to cover 3 or 5 rows at one time (Figure 6). For this reason Table 8 gives the time necessary to cover an acre with a 3-row and a 5-row machine, at speeds from 2 to 5 miles per hour. With this table and the preceding tables the rate of discharge per acre can be calculated with the following formula: The number of minutes to cover an acre at the speed the rig is traveling X the discharge in gallons per minute of the nozzles used X the number of nozzles on the rig = the volume of spray material discharged per acre. For example: With a 3-row machine going 2½ miles an hour with a No. 3 discharge disc giving .54 gallons per minute at 300 pounds pressure and with 15 nozzles, the volume per acre in gallons would be 11.00 X .54 X 15 = 89.1 gallons. To attain a discharge of 100 gallons per acre, it would be necessary to increase nozzle size, decrease speed, or increase the number of nozzles on the boom.

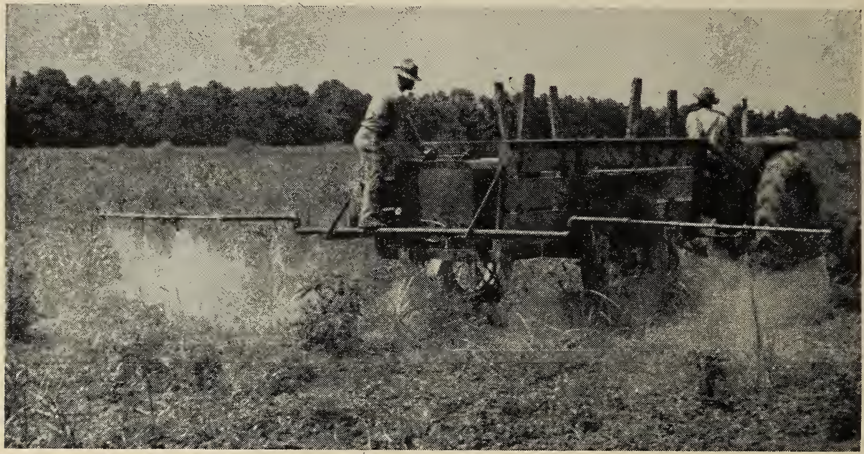

FIGURE 6. Mr. F. L. Price, Thibodaux, Sprayed More Than 700 Acres With This Equipment. It Consisted of a 150-gallon Tank in a Cane Cart with a Homemade Boom. The Boom Extensions Fold Back at the Reversed Elbows. He Used a 3-row and a 5-row Boom.

Thus, data from the dilution and time tables together with the nozzle discharges at the pressure used from Tables 5, 6, and 7, will enable one to calculate the quantity of water and pounds of 2,4-D per acre.

Heavy dews are present in April, May, and June. It has been estimated by the writers that the volume of dew present on the vegetation represents from 3 to 5 times more water than dry plants will have when sprayed at the rate of 100 gallons per acre. This heavy dew not only dilutes the spray but also causes considerable runoff or drip. It is believed that some of the erratic results observed in 1945 and 1946 were caused by spraying plants heavily laden with dew, as well as failure to apply the proper amount of 2,4-D per acre.

Spraying Versus Dusting

Attention the past season was focused on dilute sprays because of the equipment available. The spray solutions were made so that 100 gallons per acre could be applied. This can be applied in 10 to 12 minutes, and in several instances it took 45 minutes to refill and get back in the field. This time loss cut the acreage that could be covered. Also, the weight of the water requires bulky equipment, large wheels and big tires, as well as considerable tractor power, when spraying is done on wet sugarcane soils.

Because of the above difficulties a dust formulation was tried and it was found as effective as dilute sprays when applied at the same rates. The advantages of the dust are that a 100-pound hopper can carry enough dust for 10 acres at one filling. At a speed of four miles per hour with a swath 30 feet wide, it is possible to dust 14 acres per hour. It is possible to dust 100 acres in an hour by airplane.

The disadvantages of dusts are that they drift more readily and farther than sprays. A slight wind carried dust 72 feet from the row in which the power duster was being used. Drift from airplane application has been observed from ½ to 1 mile away. This drift may be dangerous to fields of other crops close by. Another disadvantage of airplane dusting is that it has been necessary to contract for the plane several days in advance and thus it is not always possible to choose good weather conditions. If applied in a rainy period a certain amount of the spray and dust can be washed off.

One of the newer developments which will be tested in 1947 is the use of spray concentrates applied at the rate of 6 to 10 gallons per acre. With a 55-gallon drum on each side of a tractor, it will be possible to carry sufficient spray to cover from 10 to 18 acres at one filling.

Another development needing further investigation is the drilling of 2,4-D dusts into the soil as a soil treatment for killing the germinating seeds of sensitive plants. It has been found that germinating seeds can be killed at very low concentrations whereas plants 6 to 8 inches tall are not killed at the same concentrations.

Recommendations

1. Dilute sprays should be used at a concentration of 2,000 ppm and a volume of 100 gallons per acre or equivalent to control alligator weeds on land. This volume and concentration is equal to 2 pounds of 80 per cent 2,4-D or 2½ pounds of 70 per cent 2,4-D per acre.
2. Spray middles and ridges.
3. Allow 7 to 10 days to elapse after spraying before working the soil. This will allow time for the toxic principle to pass into the root system.
4. Apply dilute sprays after the dew has dried.
5. Apply dusts while the vegetation is wet with dew.
6. Use 2,4-D with care, as drift of sprays and dusts can injure cotton, sweet potatoes, okra, tomatoes, and legume crops.
7. Ten to 12 pounds of 15 per cent dusts will give good control of alligator weed on sugarcane while the cane is less than 2 feet tall. Larger cane may take more if the dust is applied by airplane. Twelve pounds of a 15 per cent dust per acre is equal to 100 gallons of a 2,000 ppm solution. Ten pounds of dust per acre will make a very thin deposit that is barely visible on the vegetation in a field. It can be detected by the sheen on the foliage.

8. The control of alligator weed in water is more difficult than on land. A double strength solution applied at the rate of 200 to 300 gallons per acre has given reasonable control of alligator weeds growing in water. Two or three sprayings a year may be necessary.

Acknowledgements

The writers wish to acknowledge the splendid cooperation of Messrs. B. Thibaut, F. L. Price, Morris Tregre, L. Levert, S. C. Munson, T. Duplantis, J. Legendre, and R. Boudreaux, on whose plantations the spraying and dust tests were located; of Mr. Leo Hartman, Delta Dusting Corporation, for the pioneering applications of 2,4-D by airplane; and of the following chemical companies, which have generously contributed materials for testing since the inception of the weed investigations in 1944: Acme White Lead and Color Works, American Chemical Paint Co., American Cyanamide Co., J. T. Baker Chemical Co., Bartlett Chemicals, California Spray-Chemical Corp., Chapman Chemical Co., Chipman Chemical Co., Dandi-Deth Chemical Co., Dewey and Almy Chemical Co., The Dow Chemical Co., E. I. DuPont de Nemours & Co., Gallowhur Chemical Corp., General Chemical Co., Hammond Paint and Chemical Co., J. I. Holcomb Mfg. Co., Innis Speiden & Co., The Koehler Sales Co., Koppers Co., Michigan Chemical Co., Monsanto Chemical Co., Naugatuck Chemical Co., N. J. Zinc Sales Co., Niagara Sprayer & Chemical Co., John Powell & Co., Ralston Purina Co., Standard Agricultural Chemicals, Inc., Standard Oil Co. of New Jersey, Stauffer Chemical Co., Schuylkill Chemical Co., Shell Development Co., Sherwin-Williams Co., Tennessee Copper Co., Thompson-Hayward Chemical Co., Thompson Horticultural Chemicals Corp., U. S. Rubber Co., Velsicol Corp., and Water Weed Exterminating Co.

LOUISIANA BULLETIN NO. 411 FEBRUARY 1947

THE USE OF 2,4-D IN RICE FIELDS FOR THE CONTROL OF WEEDS

By

T. C. RYKER AND CLAIR A. BROWN

Rice being dusted for weed control on farm of Robert Bros., Burnside, Louisiana

LOUISIANA STATE UNIVERSITY

AND

AGRICULTURAL AND MECHANICAL COLLEGE
AGRICULTURAL EXPERIMENT STATION
W. G. TAGGART, *Director*

The Use of 2,4-D in Rice Fields for the Control of Weeds

T. C. RYKER AND CLAIR A. BROWN[1]

Weeds in rice fields cost growers thousands of dollars each year. This loss results from the cost of labor to pull certain of the weeds by hand, from the lower yields resulting when these weeds are not removed, and from the lower quality of the product when weed seeds are present. The cost of removing indigo and curly or frizzly indigo by hand may vary from one to as much as ten dollars per acre, depending upon the density of the weeds. The problem has been further complicated in recent years by lack of sufficient labor to pull weeds. This will probably continue since the industry is becoming geared to a more complete mechanization in the growing and harvesting of rice. Furthermore, the control by hand methods is limited to two of the three principal broad-leaf weeds, indigo and curly indigo. The third weed, Mexican weed or birdeye, together with certain other weeds of lesser importance, cannot economically be removed from rice fields by hand.

The recent discovery that 2,4-dichlorophenoxyacetic acid, commonly referred to as 2,4-D, will control certain broad-leaf plants without at the same time materially injuring most true grasses has aroused considerable interest on the part of rice growers. Sufficient information has accumulated during the last two years both from experimental tests and from commercial applications to show that 2,4-D will control certain rice weeds at a relatively low cost per acre.

The purpose of the present investigations was to determine the effectiveness of these new compounds in controlling certain broad-leaf weeds in rice fields and to determine the best means of application. Following several tests made late in the season of 1945 by S. J. P. Chilton and Clair A. Brown of the Louisiana Agricultural Experiment Station, a rather large number of tests under various conditions were made in 1946. The outcome of these tests was of such a promising nature and the demand for information was so great that a preliminary report[2] was made before the final results were obtained. The present report summarizes the results to date, and gives recommendations on the use of 2,4-D in rice weed control.

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[1] Acknowledgment is made to the following companies who kindly furnished materials used in the investigations: American Chemical Paint Co., Bartlett Chemical Co., Chapman Chemical Co., Dow Chemical Co., General Agricultural Chemicals, Niagara Sprayer & Chemical Co., Sherwin-Williams Co., and Water Weed Exterminating Co.

[2] Brown, Clair A. and Ryker, T. C. The Control of Weeds in Rice Fields with 2,4-D. *The Rice Journal* 49: No. 8, 1946.

Experimental Methods

For most of the tests, paired 1/50-acre plots were selected for uniformity of growth of the rice and of weed infestation. One plot was treated and the other was left untreated to serve as a control. For the most part, two of the various formulations were used, (1) the acid plus soda ash, and (2) the sodium salt of 2,4-D. They were applied either as a spray or as a dust. A 1,000 parts per million concentration of 2,4-D in water was applied at the rate of 100 gallons per acre with a knapsack sprayer. The dusts consisted for the most part of material containing 10 per cent or 15 per cent of the acid. The dusts were applied with a small Root hand duster early in the morning or late in the evening, while the air was relatively quiet. With this hand duster it took approximately 20 pounds of material per acre for good coverage.

Weed counts were made from 4 to 8 weeks after treatment. Counts were made of all surviving weeds and did not evaluate the size of the weeds remaining in the plots. The counts were obtained by dropping a one-foot-square frame at nine fixed points in each plot and counting all weeds within the frame.

Yields were obtained by cutting two samples $3\frac{1}{2}$ by 12 feet in each plot. As far as possible the samples were taken to include the same drill rows in the treated plots as in the untreated ones. The samples were air dried and threshed separately. The yields were computed in barrels per acre.

There were also several tests in which the dust was applied by airplane. These were supplemented by observations made in fields commercially dusted by plane.

The Effect of 2,4-D on Rice Weeds

While the manner in which 2,4-D compounds kill weeds is not clear, the growth processes of the plants are severely disturbed. Within a few hours after treatment the plants wilt slightly, and the stems become bent and twisted. In time, various malformations develop, including root and bud proliferations. The leaves slowly lose their green color, and in time, die and become dry. The stems and roots gradually die. It may take from two to four weeks for the plants to die. Weeds affected but not killed may either recover in two or three weeks and show apparently normal growth thereafter, or upon recovery may show an abnormal type of growth. The sensitivity of different broad-leaf plants to 2,4-D varies considerably. Indigo has been one of the most sensitive, while Mexican weed has been quite resistant except during the seedling stage.

Experiments showed that the younger and more vigorously growing plants were the most easily killed. In addition to volume and concentration of the material, other factors such as season and temperature were also found to be important.

The rice weeds controlled with 2,4-D include:

Alligator weed, *Alternanthera philoxeroides* (Mart.) Griesb.
Bladder pod or old fashion coffee bean, *Glottidium vesicarium* (Jacq.) Harper.
Cocklebur, *Xanthium americanum* Walt.
Curly indigo (frizzly or silvery), *Aeschynomene virginica* (L.) B. S. P.
Goose weed, *Sphenoclea zeylanica* Gaerth.
Indigo, *Sesbania macrocarpa* Muhl.
Mexican weed or birdeye, *Caperonia castaneaefolia* (L.) St. Hil.
Mule ear, *Heteranthera limosa* (Sw.) Willd.
Redweed, *Melochia corchorifolia* L.
Sagittaria, *Sagittaria* spp.
Sedges: yellow sedge, *Cyperus iria* L.
    tadpole sedge, *Rynchospora corniculata* (Lam.) Gray.
        Fimbristylis miliacea Vahl.
Toothcups or redstem, *Ammania coccinea* Rottb.
Turtle back, dayflower, or batwing, *Commelina* spp.
Water hyacinth, *Piaropus crassipes* (Mart.) Britton
Water primrose, *Jussiaea* sp.

The Effect of 2,4-D on the Rice Plant

Young rice seedlings treated with 2,4-D developed a noticeably darker green color and showed a definite retardation in growth for a period of about two weeks. The base of the plants became swollen and

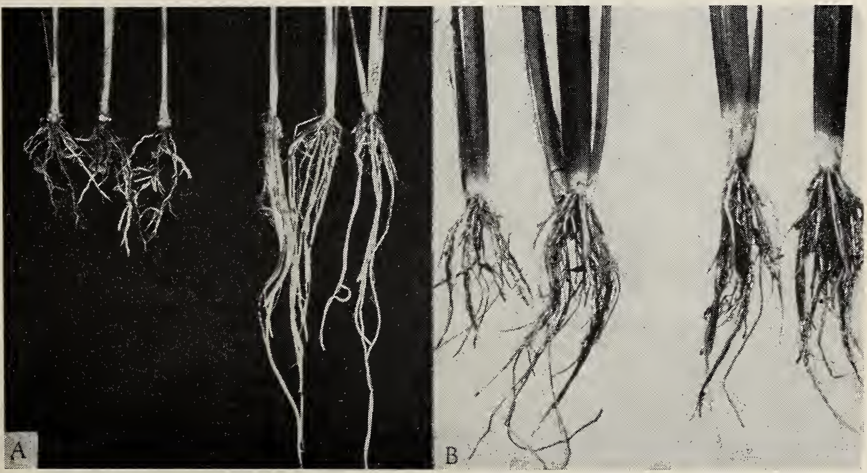

Figure 1.—The effect of 2,4-D on root systems of young rice plants treated before flooding. *A*. Rice (on left) one week after treatment, showing stunted roots as compared to non-treated plants (on right). *B*. Plants from the same two plots as in *A* taken three weeks after treatment, showing apparent recovery.

large stubby roots emerged. This was especially noticeable when plants were treated before flooding. Shortly after flooding the treated plants made a marked recovery and developed a normal root system within two to three weeks. This is shown in Figure 1. Plants treated after their water root system had developed, showed less of the stunting effect, but did turn a noticeably darker green color, which was evident throughout the growing period. Plants treated at heading time showed a blasting of many of the florets. The hulls remained open and frequently a small abnormal grain developed within the open hulls (Fig. 2). In addition, they usually showed a reddish brown discoloration. Heavy dosages at this time sometimes induced bending of the stems at the upper nodes. There were also indications that tillering had been inhibited to some degree in several of the tests. Plants treated prior to heading, headed normally and produced viable seed.

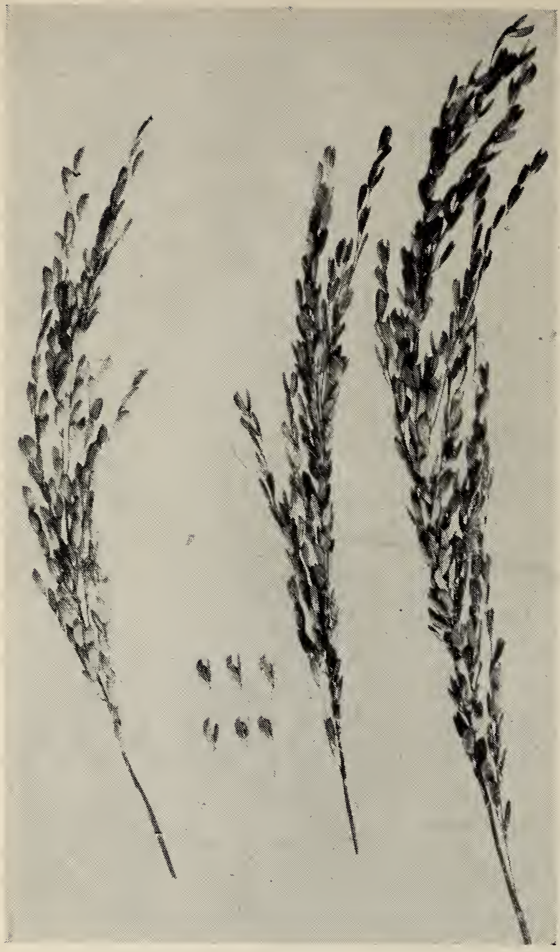

FIGURE 2.—Zenith rice dusted at heading time on farm of E. Hebert, Kaplan, Louisiana, showing injured panicles on the right as compared to normal panicle on the left.

The Effect of Time of Treatment on Weed Control

The most effective control of Mexican weed or birdeye was obtained by treatment before flooding, followed within two days by a good water coverage. In ten tests an average of 75 per cent of the Mexican weed plants were killed (Table 1). However, treatments made from one to two weeks after the initial flooding were also effective, an average of 68 per cent of the plants being killed in the four tests made. In tests made

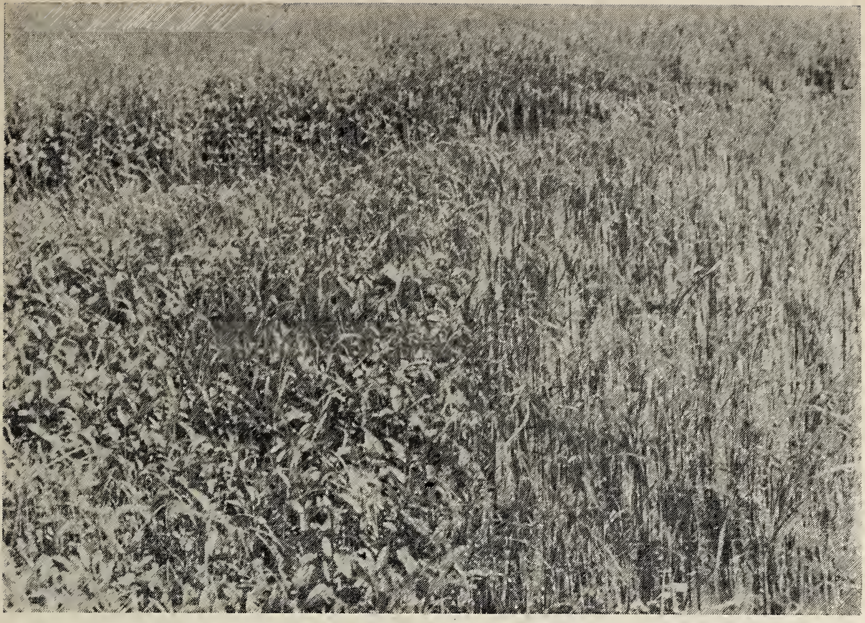

FIGURE 3.—The effect of 2,4-D on Mexican weed three weeks after treatment. Plots on farm of N. Zaunbrecher treated previous to flooding. Treated plot on the right.

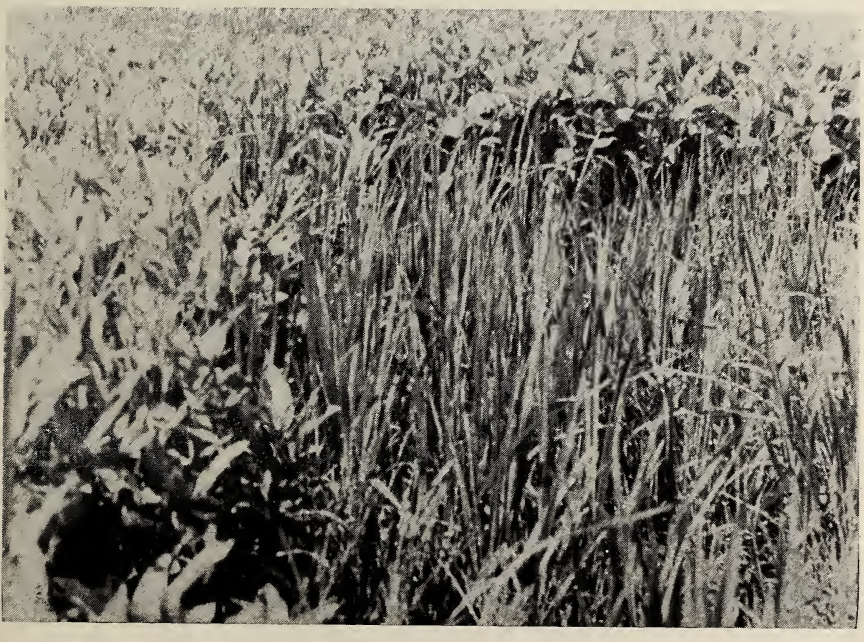

FIGURE 4.—The effect of 2,4-D on Mexican weed six weeks after treatment. Plot on farm of P. J. Thevis treated shortly after flooding. Untreated area to left and in background.

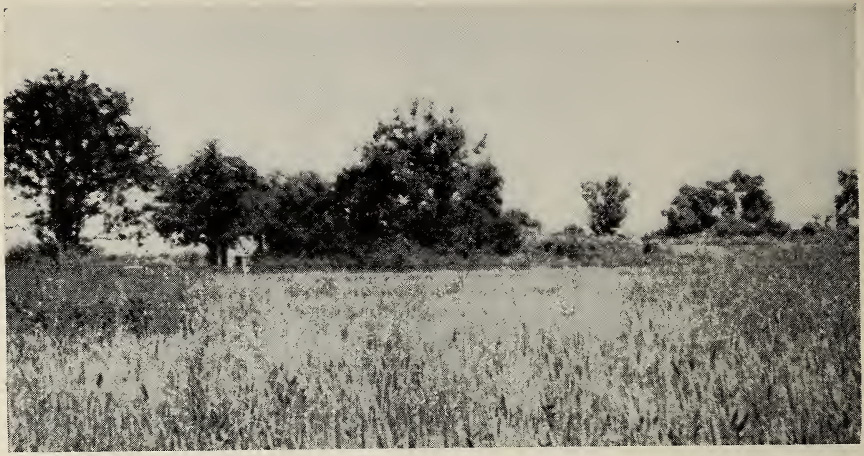

Figure 5.—The effect of one application of 2,4-D on indigo on farm of Robert Bros., Burnside, Louisiana. Treated area in center.

three weeks or more after flooding, the Mexican weed was not killed by the treatments, even when the dosage was doubled. Typical plots treated before flooding and others treated after flooding are shown in Figures 3 and 4.

TABLE 1. Effect of time of application of 2,4-D on control of Mexican weed in 1946 (Tests on 12 farms in 6 parishes)

Location of test	Parish	No. weeds per square yard		Per cent killed
		control	treated	
Treated before flooding				
R. Andrus	Acadia	146	18	88
J. Heinen	Acadia	108	16	85
L.B. Lawson	Acadia	587	247	58
Pierce	Acadia	23	4	83
N. Zaunbrecher	Acadia	168	11	93
R. Robert	Ascension	60	43	28
G. Lyons	Jefferson Davis	16	0	100
C.P. Dugal	St. Landry	142	53	63
O.L. Pollangue	St. Landry	155	44	72
J. Zaunbrecher	Vermilion	69	9	83
	Average	147	45	75
Treated one to two weeks after flooding				
P. Andrus	Acadia	202	130	36
R.J. Thevis	Acadia	142	13	91
R. Robert	Ascension	63	14	78
L.E. Fontenot	Evangeline	118	41	65
	Average	131	50	68

Experiments with indigo showed that it could be killed at any stage of development. A portion of an experimental plot is shown in Figure 5. However, less 2,4-D was necessary to kill the plants when they were small.

Tests on curly indigo made previous to or shortly after flooding gave somewhat erratic results, but for the most part very few plants were killed. Dust treatments were more effective than the spray treatments. Dust treatments made at the usual weeding time killed back the tips of the plants, but the plants in most cases recovered in about three weeks. A second application made at this time did give satisfactory control in the two tests in which it was tried. Results in one of the tests are shown in Figure 6.

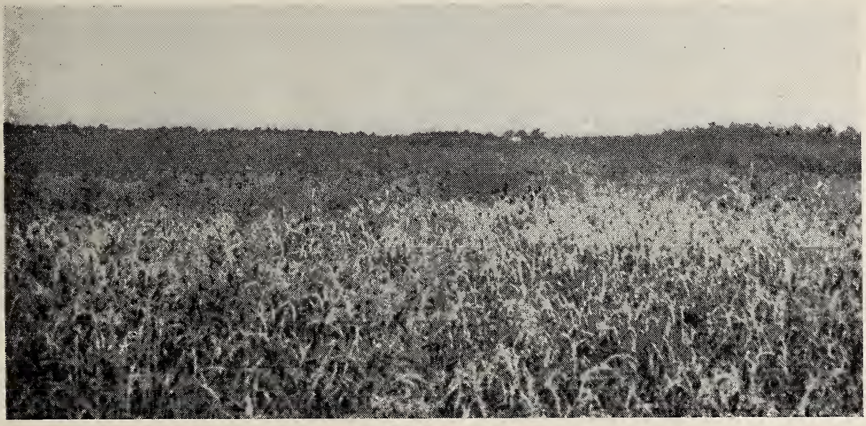

FIGURE 6.—Effect on curly indigo of two applications of 2,4-D dust made three weeks apart on Pierce farm at Morse, Louisiana. Untreated area in background.

Comparative Effectiveness of Sprays and Dusts

Very little dust was available during the early part of the growing season, and a careful comparison of dusts and sprays could not be made. In one test on Mexican weed made before flooding, where 2,4-D was sprayed on the plants, 88 per cent were killed as compared to only 75 per cent with the dust. On the other hand, in another test made two weeks after flooding, only 36 per cent of the plants were killed with the spray as compared to 75 per cent with a dust with an acid content of 10 per cent. In each of these tests, however, approximately twice as much 2,4-D was applied in the dust as in the spray.

Both sprays and dusts gave satisfactory control, but in the limited number of tests made, dusts were more effective than sprays in the control of curly indigo.

Yield data were not secured in most plots in which indigo and curly indigo were the principal weeds, since these weeds were eventually pulled or treated in the control plots in order to prevent seeding. However, in one test on the Daughenbaugh farm near Lake Charles, in which indigo was relatively abundant, in plots treated June 7 with a 10 per cent dust all plants were killed. The entire field was dusted by plane the middle of August and most of the indigo in the field was killed. Yield data gave an average of 14.9 barrels per acre for the plots treated June 7, and 9.0 barrels for the control plots. Since growers are well aware of the damage that indigo may cause in rice fields, yield data on the effect of this weed did not seem as important to obtain as with Mexican weed.

The increase in yields that may be expected from the control of Mexican weed is of vital importance to the grower, since in the past he has been unable to evaluate the damage that it caused. This is because rice is able to compete to some degree with this weed. The results of yield tests carried out on nine farms are given in Table 2. The increases in yield from the control of Mexican weed varied from 1.4 barrels per acre on the Lyons farm, where the weed infestation was very light, to 12.0 barrels per acre on the Thevis farm, where the weed infestation was heavy. In several tests made late in the season, the weeds were not killed but their growth was retarded somewhat by the 2,4-D treatment. Small increases in the yields of the treated plots were secured, but the increases were not sufficient to justify a late treatment. In one test in which there was both heavy grass and Mexican weed infestation, the control of the Mexican weed with 2,4-D actually resulted in a decrease in yield. In this case the temporary stunting induced in rice by the 2,4-D probably enabled the grass to outgrow the rice.

Airplane Applications of 2,4-D

The first application of 2,4-D on rice by plane in Louisiana was made May 28, 1946, on the farm of M. O. Marquette, Jeanerette. This consisted of two tests. In test one, a field of the Bluebonnet variety was dusted three days prior to flooding with a dust containing 2½ per cent of the 2,4-D acid at the rate of approximately 15 pounds per acre. The second test was made in a field of the Zenith variety about two weeks after flooding. In this test a 23 per cent dust was applied at the rate of

TABLE 2. Effect of control of Mexican weed with 2,4-D treatments on yields of rice in 1946.

Location of test	Parish	Variety	Yield in bbls.[1] per acre control	Yield in bbls.[1] per acre treated	Difference in bbls. per acre
N. Zaunbrecher....	Acadia	Zenith	7.6	14.4	+ 6.8
J. Heinen.........	Acadia	Fortuna	9.5	11.3	+ 1.8
O. L. Pollangue....	St. Landry	Fortuna	10.0	12.7	+ 2.7
G. Lyons..........	Jefferson Davis	Blue Rose	11.7	13.1	+ 1.4
P.J. Thevis........	Acadia	Texas Patna	5.9	17.9	+12.0
L.B. Lawson........	Acadia	Rexoro	10.7	15.5	+ 4.8
R. Andrus.........	Acadia	Rexoro	9.5	13.4	+ 3.9
C.P. Dugal........	St. Landry	Rexoro	10.3	16.7	+ 6.4
		Average.....	9.4	14.4	+ 5.0

[1] One barrel is 162 pounds of rough rice, or 3.6 bushels.

10 pounds per acre. The weed control was determined by staking off four one-square-yard plots in each test and making weed counts in these blocks at the time of treatment and approximately four weeks later.

The results showed that in the test with the 2½ per cent dust applied prior to flooding, the alligator weed was not controlled, but Mexican weed and curly indigo were controlled in areas in which there was good water coverage. In the test with the 23 per cent dust applied after flooding, there was excellent control of alligator weed, Mexican weed and indigo. On the other hand, only about 50 per cent of the curly indigo plants were killed. It should be pointed out that in the test made prior to flooding there was less than half a pound of 2,4-D dust in the 15 pounds of 2½ per cent dust applied per acre. This is probably the reason for the poor results on the alligator weed.

Additional tests were made June 5 and June 27 on Mexican weed in the Crowley area. In these tests a 10 per cent dust applied at the rate of 10 pounds per acre was used. The weeds were 12 to 15 inches in height at the time of treatment. The results showed that Mexican weed could not be controlled when treated at this stage of development.

Following the success of the initial dusting, approximately 3,000 acres of rice were treated in Louisiana by plane. In most applications a 10 per cent dust was applied at the rate of 10 pounds per acre. However, some 15 per cent dust was used. Most fields were treated at a time when the indigo was quite large and during a period of very frequent rains. In a number of instances rain followed a few hours after treatment.

Observations showed that indigo was killed in most fields, but that Mexican weed and curly indigo were not. Instances of poor kill of indigo could be accounted for either from poor coverage with the dust or from rain following too closely after treatment. Mexican weed and curly indigo, while severely affected, usually recovered in about three weeks. Several fields were treated shortly after flooding and in these fields relatively good control of Mexican weed and curly indigo was obtained.

Means of Application

The most economical means of treating fields is by plane, and agencies equipped to treat considerable acreage are now available in the area. The cost of application usually runs around six cents per pound. With an application of ten pounds to the acre the cost would be 60 cents. The present planes are equipped to apply dust, but should sprays be found more suitable they could easily be changed over. However, there are areas of localized weed infestation that will not justify application by plane. Also, there are fields in which the drift from planes would endanger nearby cotton, sweet potatoes, vegetables and shrubs.

A small hand duster is suitable for small areas and for the control of weeds on levees, ditches and canals. Hand sprayers may be used also but are much more laborious to use than hand dusters.

There are a number of different power dusters and sprayers that can be adapted for use in rice fields. However the power sprayer that uses the conventional rate of 100 gallons of spray per acre does not seem suitable because of its size, weight and the amount of water that is required. One of the newer developments in power sprayer equipment is a machine from which one may get good coverage with only 5 to 6 gallons of spray per acre. A spray concentrate could be used in such a machine, and while it has not been tried on rice, there seems no reason why it should not be effective.

Discussion

While there is little question concerning the effectiveness of 2,4-D in the control of certain rice weeds, further investigations are necessary to determine the comparative effectiveness of the various 2,4-D compounds and the best means of applying them. Further information on the injurious effect of 2,4-D on rice and on possible means of lessening this injury must be obtained. It should be pointed out that flooding still remains the basic method for the control of grasses and other weeds, and that adequate water coverage is essential to good control of weeds with 2,4-D.

In order to control Mexican weed it is necessary that the weeds be treated when the plants are quite small. This is either before flooding or within one to two weeks after flooding. At this stage rice is injured to some degree and hence care should be exercised that an overdose of the chemical is not applied. This is especially true in treating before the initial flooding. Heavier dosages may be used after the rice plant has developed a good water root system. In spite of some injury to seedling rice the increases in yield obtained from the control of such weeds as Mexican weed are so marked as to make 2,4-D treatments advisable. On the other hand, it is questionable if treatment should be made where a heavy growth of grass is present which has not been controlled by flooding. There is also the possibility that the weed infestations may be cleaned up following several years of treatment. It is not known how long the seed of the various weeds will stay viable in the soil, but with no new crops of seed being produced it may be possible to reduce the weed infestation to the point where treatment would no longer be necessary.

The ease of control of indigo is such that the principal question is whether or not it can be treated with 2,4-D more economically than it can be pulled by hand. Curly indigo, on the other hand, presents more of a problem. The initial tests indicate that it is best treated when small and that two applications of 2,4-D are necessary for effective control. It may be found that a heavier dosage or that some 2,4-D compound other than the ones tried will prove more effective in the control of this pest. Since indigo is a legume, there is the possibility that nitrogen is made available to the rice plants when it is killed.

The cost of 2,4-D treatments, to a large degree, is the cost of the materials. The price of 2,4-D will probably decrease as the production increases.

The minimum dosage for most weeds is one pound of 80 per cent

2,4-D per acre. This dissolved in 100 gallons of water gives a concentration of 1,000 parts per million. Since the materials available for the most part vary between 60 and 80 per cent of 2,4-D, proportionately increased amounts will have to be used with materials containing less than 80 per cent to get the above equivalent. In the case of dusts the 2,4-D content is usually given in terms of percentage of 2,4-D by weight.

There are additional problems in weed control that hold promise for the future. One of these is to find a material at low cost that can be applied to the soil and will kill all weed seeds, including those of the grasses and red rice, and that will be dissipated in time to permit planting rice a short time after treatment. This may be possible with 2,4-D since it is very lethal to all germinating seed and does not show the differential action on germinating seed that it does when applied to growing plants. Another possibility is the promise of a general herbicide that will control all weeds and grasses in canals and drainage ditches.

Recommendations

Dust. Use 10 pounds of a 10 per cent dust per acre 1 to 3 days before flooding. After rice has been flooded or after a maximum emergence of weeds in non-flooded areas, such as on levees, use 10 to 15 pounds of a 10 per cent dust or 10 pounds of a 15 per cent dust.

Spray. Use at the rate of 14 ounces of pure 2,4-D per 100 gallons of water per acre. This requires one pound of an 80 per cent, 1¼ pounds of a 70 per cent and 1½ pounds of a 60 per cent material. Because of the injury to rice, the minimum rate should be used in treatments before flooding; but the rate may be increased in treatments made after flooding.

Caution. Equipment used with 2,4-D should not be used later for applying insecticides and fungicides on vegetables. It is almost impossible to clean equipment sufficiently for that purpose. Care also must be taken to see that the spray or dust does not drift to fields where extremely sensitive plants such as cotton, sweet potatoes, beans and tomatoes are growing. However, 2,4-D is not toxic to man, livestock or fish.

Do not treat after rice has headed.

Mexican weed.. Treat previous to flooding or within two weeks after flooding. If treated before flooding, follow within 1 to 3 days with a good coverage of water. If treated after flooding, the water should be shallow in order to permit coverage by the herbicide of the weeds that are too short to stick out of a deep flooding. Follow with good water coverage. If this is not possible, treat when maximum weed emergence has occurred. The same procedure should be followed in treating weeds on levees. Do not treat if there is a heavy growth of grass that cannot be controlled by the water.

Indigo. Treat at any time, but preferably while the plants are still relatively small.

Curly indigo. Treat preferably when plants are small. Make a second application 3 to 4 weeks after the first one when plants begin to recover.

Other weeds and sedges. The same as for Mexican weed.

Summary

The results of tests with 2,4-D in the control of certain broad-leaf rice weeds are reported.

A spray at a concentration of 1,000 parts per million applied at the rate of 100 gallons per acre and both a 10 per cent and a 15 per cent dust applied at the rate of 10 to 20 pounds per acre gave effective control.

Mexican weed was controlled and the yield of rice substantially increased when treatments were made just before or within two weeks after flooding.

Indigo was effectively controlled at all stages of development.

Curly indigo was best controlled when young and usually required two applications about 3 weeks apart. Dusts were more effective than sprays.

Recommendations for the control of the various weeds are given.

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SEED TREATMENT OF RICE

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SEED TREATMENT OF RICE

By

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In Louisiana, reasonably good stands of rice have usually been secured in years when the growing conditions have been satisfactory. However, in years when the temperatures have been unseasonably low the stands in the early plantings have sometimes been poor, and in some cases it has been necessary to plow up some fields and replant. A seed treatment that would be useful in securing better stands is needed.

Tests have been made in the past with various seed treatments, but the increases in stands from the treatments which have been reported have not been sufficient to warrant general recommendations. Recently, however, several new fungicides have come on the market, and some of these seem to have possibilities with rice. In order to test these new materials, studies were initiated in 1943 and were continued until 1946. The results show that rather substantial increases in stand can be obtained with certain of these fungicides. The purpose of this bulletin is to bring together the results of these tests and to make recommendations on the use of the seed treatment which gave the best results.

Materials and Methods

With the exception of five outfield experiments, all tests were made at the Rice Experiment Station at Crowley, Louisiana. The tests at the Station consisted of planting single rod rows at the rate of 100 pounds of seed per acre. The seed were treated by shaking with an excess of the dust used and then screened to remove the excess. This was at the rate of approximately 1½ ounces per bushel. Each treatment was replicated four times, with the exception of a few tests made in 1946, when only two were used. In each year, plots were planted in March, April and May as close as possible to the middle of the month, and stand counts were secured about one month after planting. The plots were harvested when ripe, air dried, threshed and yields computed in barrels per acre.

In the five outfield tests, the seed were treated and planted with the drill that the grower was using. Stand counts were made of five rows ten feet long of treated and untreated seed in four places. Care was taken that the five rows were planted with treated and untreated seed that came from the same drill spouts.

Experimental Results

Effect on Stand. Three dusts, Arasan, Spergon and New Improved Semesan Jr., were tested the first two years. The results of stand counts on four varieties, Blue Rose 41, Fortuna, Early Prolific and Rexoro, are shown in Table I. It may be seen that Arasan gave the best results, with stand increases of about 25 per cent in the March and April plantings. There was only a 12 per cent increase in the May plantings. Spergon gave a much smaller increase in the April and May plantings, while the

TABLE 1. COMPARATIVE STANDS IN PER CENT IN PLOTS PLANTED WITH UNTREATED RICE SEED AND SEED TREATED WITH THREE FUNGICIDES, 1943 AND 1944.

No. Years	March				April				May			
	Check	Arasan	Spergon	N.Improved Semesan Jr.	Check	Arasan	Spergon	N.Improved Semesan Jr.	Check	Arasan	Spergon	N.Improved Semesan Jr.
BLUE ROSE 41												
2	28	46	41	37	39	50	40	42	70	72	72	70
FORTUNA												
2	26	39	36	36	30	35	31	35	69	72	67	67
EARLY PROLIFIC												
2	43	48	52	37	50	59	54	44	52	62	51	49
REXORO												
1	43	43	46	36	26	39	33	36	43	56	51	45
Average.......	35	44	44	37	36	46	40	39	59	66	60	58
Per cent increase...		+26	+26	+ 6		+28	+11	+ 8		+12	+ 2	— 2

New Improved Semesan Jr. was of relatively little value in any of the tests.

In subsequent tests Arasan was the fungicide principally used. The results with fifteen varieties where Arasan was used as a seed treatment are given in Table 2. These varieties include most of the present com-

TABLE 2. COMPARATIVE STANDS IN PER CENT IN PLOTS PLANTED WITH UNTREATED RICE SEED AND SEED TREATED WITH ARASAN.

Year	Variety	No. Yrs. tests	March		April		May	
			Check	Arasan	Check	Arasan	Check	Arasan
1943-46.......	Blue Rose 41	4	37	53	46	57	63	72
1943-46.......	Fortuna	4	32	40	35	42	63	65
1944-46.......	Early Prolific	3	43	49	40	49	52	62
1944-46.......	Rexoro	3	43	43	42	53	49	54
1945..........	Nira	1	43	54	66	73	49	54
1946..........	Bluebonnet	1	43	51	44	48		
1946..........	Zenith	1			34	45		
1946..........	Magnolia	1			36	43		
1946..........	Cody	1			32	43		
1946..........	Colusa	1			33	47		
1946..........	Kamrose	1			40	42		
1946..........	Arkrose	1			31	39		
1946..........	Hill Long Grain	1			24	36		
1946..........	Texas Patna	1			30	37		
1946..........	Delrex	1			39	51		
	Average.........		38	47	39	48	58	64
	Per cent increase.			+24		+23		+10

mercial varieties. While the data show difference in varietal response, this is not considered to be of significant value. However, the fact that Arasan did not appear to be toxic to any of the varieties is of considerable importance. The average increase in stand was 24 per cent in the March plantings, 23 per cent in April plantings and 10 per cent in the May plantings.

In 1944 and 1946, tests were made with Arasan on five farms. The increase (Table 3) averaged 27 per cent and ranged from 11 to 61 per cent on the different farms. The increases were greater in 1946 than in 1944. This was probably due to the fact that the 1946 season was somewhat unfavorable for the early development of rice, since many growers experienced difficulty in obtaining stands.

TABLE 3. RESULTS OF STAND COUNTS IN FIELDS PLANTED WITH UNTREATED AND ARASAN TREATED SEED AT 5 FARMS DURING TWO YEARS. NO. OF PLANTS PER 200 FT. OF DRILL ROW.

Variety	Farmer	Year	Check, No. Plants	Arasan, No. Plants	Per Cent Increase
Zenith	Lozen Leger	1944	2,392	3,236	35.3
Early Prolific	S. Higginbotham	1944	1,432	1,636	14.2
Rexoro	B. Hoyt	1944	3,233	3,603	11.4
Fortuna	J. Heinen	1946	763	1,229	61.1
Rexoro	J. Zaunbrecher	1946	811	1,216	49.9
		Average	1,726	2,184	27.0

It was also observed that in the case of Arasan treated seed emergence was about a day sooner than in untreated seed. Also, the seedlings emerged with somewhat more vigor.

Effect on Yield. The data obtained over a period of four years on the yields from treated and untreated seed are given in Table 4. The increases averaged 0.4 barrel per acre with Arasan treated seed in the March plantings, 0.4 barrel in April plantings and 0.2 barrel in the May plantings. Spergon gave a 0.5 barrel increase in March but a decrease in April and May. New Improved Semesan Jr. gave no increase in March, 0.4 barrel in April, and a decrease in May plantings.

While the increases in yield in these tests with Arasan treated seed were rather small, this would be expected since normal stands were obtained in most instances from untreated seed. Larger yields from treated seed would be expected where the stand was below the critical point for a normal yield; for example, in the test on the farm of J. Heinen in 1946, yield data were secured and an increase of 1.4 barrels per acre occurred where the seed were treated. The stand in this field was poorer than usual and the increase was probably due to the fact that the seed treatment increased the stand more nearly to that considered a normal one.

Effect of Arasan on Storage. There is always the possibility that any material which will kill microorganisms may be toxic to seed and reduce germination if the seed are treated and kept too long in storage.

TABLE 4. Yield of rice in barrels per acre in plots planted with treated and untreated seed.

Treatment	Average	Difference
MARCH		
Check	13.8	
Arasan	14.2	+ .4
Spergon	14.3	+ .5
New Improved Semesan Jr.	13.8	.0
APRIL		
Check	12.2	
Arasan	12.6	+ .4
Spergon	11.2	—1.0
New Improved Semesan Jr.	12.6	+ .4
MAY		
Check	11.0	
Arasan	11.2	+ .2
Spergon	10.2	—0.8
New Improved Semesan Jr.	10.6	— .4

Arasan: average of 4 years tests in March and April, 3 years in May.
Spergon: average of 3 years tests in March and May, and 4 years in April.
New Improved Semesan Jr.: average of 3 years tests in March and 2 years in April and May.

In order to determine if seed could be treated with Arasan and kept indefinitely, comparative germination tests of Arasan treated and untreated seed of two varieties (Blue Rose 41 and Bluebonnet) were made over a period of eight months. The results (Table 5) showed that the treated seed germinated consistently better than untreated seed in each of the seven tests made. Another interesting observation showed that at the end of the eight months only 4 per cent of the treated seed had been destroyed by the angumois moth while 12 per cent of the untreated seed had been damaged (Fig. 1).

TABLE 5. Per cent germination of untreated and Arasan treated seed following various periods of storage.

Variety		Period after treating, in months						
		0	1	2	3	5	8	Av.
Blue Rose 41	Untreated	88	90	72	70	86	78	81
	Treated	93	93	95	93	91	93	93
Bluebonnet	Untreated	91	85	81	85	82	80	84
	Treated	95	85	89	86	79	83	86

Discussion. The results given above indicate that Arasan treated seed gave considerably better stands in March and April plantings and some increase in May plantings. While yield increases were relatively small they were large in proportion to the cost of treatment, which would

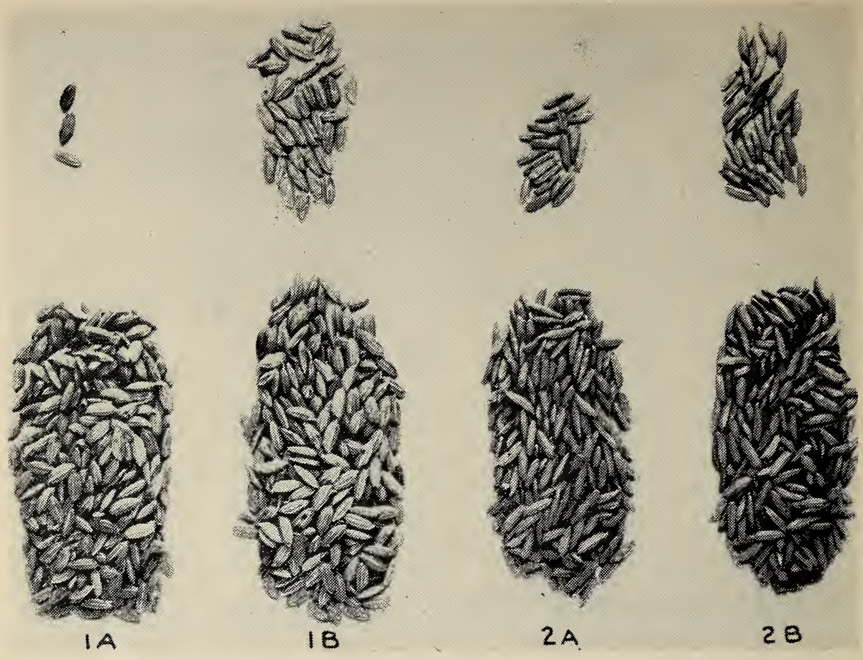


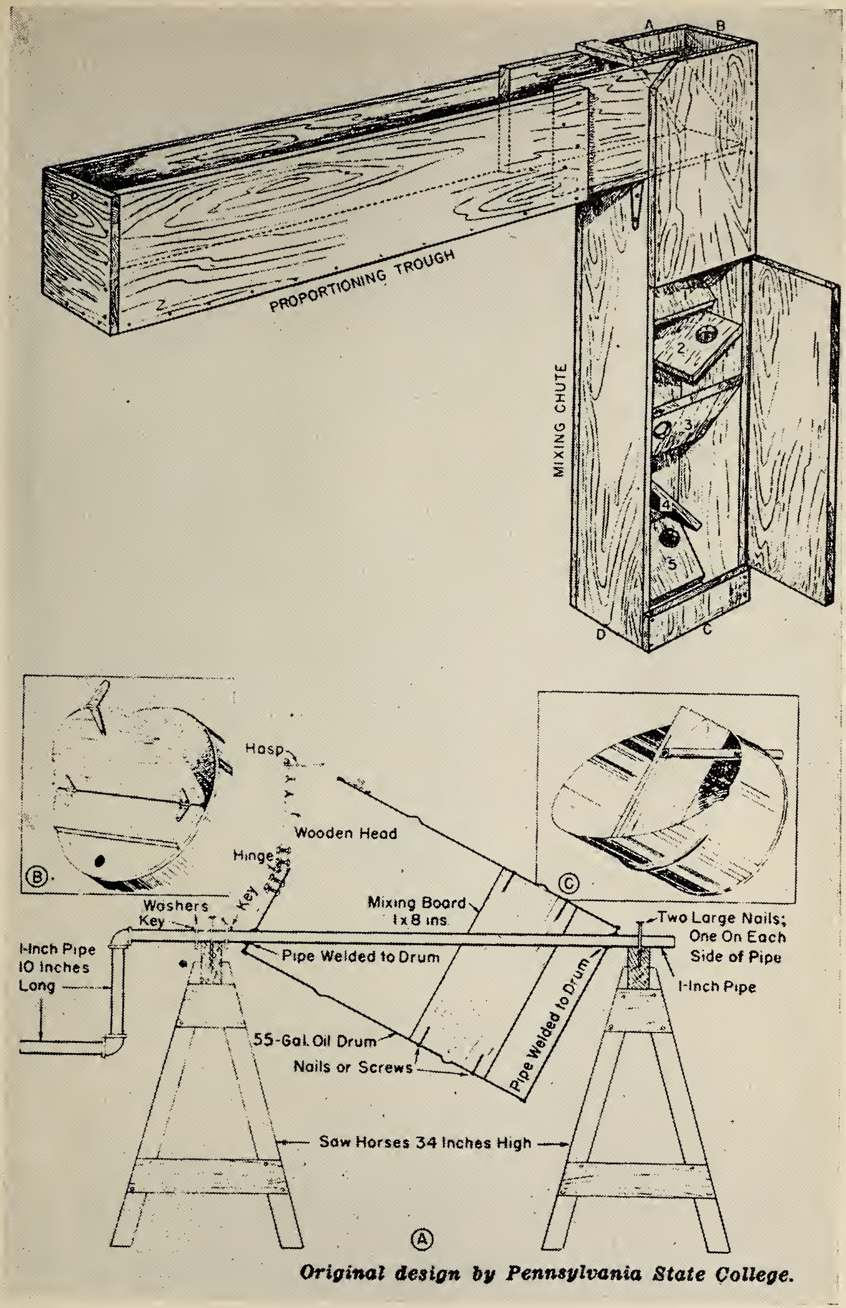
Fig. 1.—The effect of Arasan treatment on abundance of angumois moth. *1A,* Blue Rose 41, treated; *1B,* Blue Rose 41, untreated; *2A,* Bluebonnet, treated; *2B,* Bluebonnet, untreated. Top row, grains infested with moth out of 300; lower row, grains not infested.

probably not exceed 25 to 30 cents per acre. Seed treatment should also be considered as stand insurance, since the extra 25 per cent of plants obtained by treating the seed might well give sufficient plants under certain conditions to make replanting unnecessary. The fact that treated seed emerge with a little more vigor than untreated seed might well be a factor in weed control.

While very little information is available on the effect of seed treatment on seed-borne fungi, such as *Helminthosporium oryzae,* and the development of disease epidemics caused by these fungi, it is possible that it would have a helpful effect in reducing such diseases if practiced over a period of several years.

Recommendations. The Arasan dust must be mixed thoroughly with the seed. It will take about $1\frac{1}{2}$ ounces to the bushel, or 5.4 ounces to a 162-pound barrel. If used at a higher rate, the dust is wasted since larger amounts will not remain on the seed, and with much less than this rate it is difficult to cover each seed with the dust.

The seed can be treated by a number of means. It can be done by adding the dust to the seed on the floor and shoveling it thoroughly, or



Original design by Pennsylvania State College.

Fig. 2.—Two types of homemade seed treaters. Top: The Minnesota seed treater. Bottom: The barrel type.

by using a seed treater. There are several types of seed treaters that can be made at home. Two of these are shown in Fig. 2 (the barrel and the Minnesota). There are also several power seed treaters on the market that will treat as much as 30 barrels per hour, and cost from $200 to $600. These are the Gustafson seed grain treater, Fargo, N. D., and Calkins All-purpose treater, Spokane, Washington. It is probable that machines of the latter type will be available for 1947 to do custom treating. They can be operated in connection with cleaning machinery and necessitate no additional handling.

Certain care should be taken when treating seed with Arasan. First, it is somewhat toxic to human beings when breathed in, and often causes headaches and sometimes bleeding from the nose. A respirator should be used if the seed is treated in the open. Second, treated seed should not be fed to live stock, since the Arasan is poisonous. A new Arasan material in the form of a slurry has recently been developed. When the machinery for this is available, the danger to the handlers will be eliminated.

Summary

Rice seed treatment tests have been made during four years. Arasan, Spergon and New Improved Semesan Jr. were used.

Arasan gave the best results, increasing stands nearly 25 per cent in March and April plantings and 10 per cent in May plantings. Small but consistent increases in yield occurred where the seed were treated.

Recommendations on the use of Arasan are given.

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MALNUTRITION OF LOUISIANA DAIRY COWS

MINERAL STUDIES

By

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BRIEF SUMMARY OF IMPORTANT FINDINGS

Field studies of malnutrition among dairy animals in the milkshed area for New Orleans gave some indication from soil, forage, and blood analyses that a low content of calcium or phosphorus, or both of these minerals, might be the primary cause.

A controlled feeding experiment with ten grade Jersey heifers and four cows over a two-year period on a basal ration of poor quality native grass hay low in calcium and phosphorus content, and cottonseed meal or blood meal, corn, and salt failed to produce any definite mineral deficiency. (See pictures on page 17). Supplementing this basal ration with calcium (oyster shell flour) or phosphorus (sodium dihydrogen phosphate), or calcium and phosphorus (bone meal) failed to produce any detectable advantage over the basal ration when growth records, blood levels, reproduction, and lactation records were considered.

It is concluded that a low content of calcium or phosphorus in the feed is not the primary cause of malnutrition of Louisiana milking dairy cows.

The practice of allowing dairy animals to forage for themselves in the upland piney woods areas without receiving any grain mixture, hay, or access to a fertilized pasture most probably results in malnutrition associated with protein starvation, calcium and phosphorus starvation, and lack of total digestible nutrients.

ACKNOWLEDGMENTS

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MALNUTRITION OF LOUISIANA DAIRY COWS

MINERAL STUDIES

L. L. Rusoff and D. M. Seath[1]

INTRODUCTION

Malnutrition of livestock in certain areas of Louisiana is known to be present, especially during the winter months. Dairy cows of these areas are often in poor physical condition, have rough hair coats, and some show a stiffness in the joints, chew bones, and gnaw wood and pine tree tops. Animals lie down to rest often and seem very tired. Sway-backed and hump-backed animals are common sights. Some of these conditions are attributed by farmers in the area to "hollow horn," "hollow belly," "hollow tail," Bang's disease, and acorn poisoning. These symptoms, however, indicated a possible mineral deficiency of calcium or phosphorus, or both of these minerals.

Dairy cows utilize roughages as their principal source of calcium, and grain and milling by-products as their chief source of phosphorus.

It is known that the mineral content of a roughage is dependent on the character of the soil upon which it is grown. Soil analyses (11) * of the different soil types throughout the state have shown that deficiencies of calcium, phosphorus, and both calcium and phosphorus exist. In Tangipahoa Parish, a portion of the milkshed area for New Orleans, the soils are acid (pH 5.3 to 5.7); they are deficient in lime (100 to 360 p.p.m. of calcium) and phosphorus (2 to 12 p.p.m.), and the plants on these soil types respond liberally to lime and phosphate fertilization.

In order to study the possible mineral deficiencies in dairy cows, it was decided, first, to make field studies in a localized section to determine the mineral content of the forage; second, to determine the blood plasma levels of calcium and inorganic phosphorus of the cows in this area to see how they compare with normal values; and third, to set up a controlled experiment to determine if the usual natural winter rations as fed to dairy cows in Louisiana were adequate in calcium and phosphorus.

I. FIELD STUDIES

Mineral Content of Forage

Chemical analyses of the forage on various soil types often provide clues as to the existence of mineral deficiency. Low content of a mineral in forage consumed by animals is not conclusive evidence of a mineral deficiency in animals. But when forage low in mineral content is associated with mineral deficiency symptoms in animals along with a low level of the mineral in the blood, the deficiency can be diagnosed. Feeding practices can then be initiated to prevent or correct the deficiency.

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* Figures in parentheses ( ) refer to literature cited.

Home-grown hay and corn were collected for analyses from farms in Tangipahoa Parish during 1943. The calcium values for the hays (Table 1) ranged from 0.25 to 0.77 per cent on air-dry basis, the average being 0.48 per cent; the phosphorus values were from 0.098 to 0.18 per cent, the average value being 0.15 per cent. For corn, calcium ranged from 0.025 to 0.036 per cent, the average being 0.03 per cent, and phosphorus from 0.17 to 0.34 per cent, the average being 0.23 per cent. These values are low when compared to hays and corn grown on fertilized pastures.

TABLE 1. CALCIUM AND PHOSPHORUS VALUES OF 34 SAMPLES OF HOME-GROWN HAY AND CORN IN TANGIPAHOA PARISH (MILKSHED OF NEW ORLEANS)

Feeds	Number of Samples	Range		Average	
		Calcium	Phosphorus	Calcium	Phosphorus
		%	%	%	%
Native hays....................	20	0.25–0.77	0.098–0.18	0.48	0.15
Cracked or ground corn.........	14	0.025–0.036	0.17–0.34	0.03	0.23

Tests by Seath and Rusoff (14) have shown that carpet grass from an unfertilized pasture on one farm contained 0.33 per cent calcium and 0.105 per cent phosphorus. After fertilization of the pasture with lime and phosphates, the calcium content rose to 1.21 per cent and the phosphorus value to 0.306 per cent. This was a total increase of 267 per cent for calcium and 191 per cent for phosphorus, which was the average of clippings taken during three different seasons of the year.

Blood Studies

Blood analyses for hemoglobin content, calcium, and inorganic phosphorus of 187 milking cows representing 15 herds distributed over Tangipahoa Parish were made by Rusoff and Seath (13) in 1943. The hemoglobin values (Dare) ranged from 15.4 to 18.8 grams, averaging 17.1 grams per 100 c.c. of blood. These are much higher than the normal values (12) for dairy cows. The soil of this area is rich in iron, which might explain the high values. Thus, no nutritional anemia was encountered. Serum calcium ranged from 7.3 to 12.8 mg. per 100 c.c. (mg. per cent) and serum inorganic phosphorus ranged from 3.0 to 11.9 mg. per cent. The average values were 10.45 mg. per cent for calcium, and 6.2 mg. per cent for phosphorus. Significant differences between herds (analysis of variance) were found for blood calcium and inorganic phosphorus. Some of the animals in the herds had lower blood calcium and inorganic phosphorus values than "normal" values reported for Louisiana dairy cows (12).

Rusoff and Piercy (12) in 1944-1946 studied the blood picture of 32 "normal" dairy cows in the Louisiana State University herd at Baton Rouge and in the U.S.D.A. experimental Jersey herd of the Bureau of Dairy Industry at Jeanerette, Louisiana. Samples were taken monthly over a period of approximately two years. These herds are managed and fed better than the average in the state. Monthly findings showed a range of 9.00 to 15.28 mg. per cent for plasma calcium, averaging 10.89 ± .67 and 11.36 ± .5 mg. per cent, respectively, for the animals in the two herds; and 3.50 to 9.00 mg. per cent, average 5.77 ± .41 and 5.02 ± .03 mg. per cent, for inorganic phosphorus. Three of the herds studied in Tangipahoa Parish had blood calcium values below the 9.00 mg. per cent lower limit of the range for "normal" values found for calcium, and the 3.50 mg. per cent for inorganic phosphorus. (See Table 2.) The mean values for blood calcium and inorganic phosphorus for the animals in the milkshed area are similar to those reported by Rusoff and Piercy (12) for "normal" dairy cattle in Louisiana.

TABLE 2. A COMPARISON OF THE BLOOD VALUES FOR CALCIUM AND INORGANIC PHOSPHORUS OF DAIRY COWS IN HERDS WITHIN THE MILKSHED AREA OF NEW ORLEANS AND "NORMAL" (BETTER-FED-AND-MANAGED THAN AVERAGE) DAIRY COWS IN LOUISIANA

Herd	Range (mg. per 100 ml. of plasma)*		Average (mg. per 100 ml. of plasma)	
	Calcium	Phosphorus	Calcium	Phosphorus
	mg. %	mg. %	mg. %	mg. %
Field herds (13)	7.30–12.80	3.00–12.80	10.45	6.20
"Normal" (L.S.U. herd) (12)	9.00–15.28	4.00– 8.80	10.89 ± .67	5.77 ± .41
"Normal" (Jeanerette herd) (12)	9.35–13.87	3.50– 9.00	11.36 ± .15	5.02 ± .03

*Reference (13) refers to blood serum.

Improper feeding practices were being used on each farm studied in the milkshed area. In most of the herds the cattle were fed liberal amounts of concentrates that contained one part cottonseed meal or soybean meal and one part corn. Only small amounts of roughage were fed and this usually consisted of a low quality native hay or lespedeza. An economic survey (5) of dairy farmers in the Kentwood area of southeastern Louisiana in 1937-1938 disclosed that an average of only 200 pounds of hay was consumed per animal per year. These practices might explain the higher blood phosphorus values, since the concentrates—cottonseed meal in particular—are relatively high in phosphorus. The low consumption of hay, on the other hand, would indicate a low calcium intake in winter months, inasmuch as cows obtain most of their calcium from hay.

II. CONTROLLED MINERAL EXPERIMENT

This phase of the experiment was set up to test whether the usual natural winter rations as fed to cows in Louisiana were adequate in calcium and phosphorus for good health, reproduction, and lactation. By supplementing the natural rations with minerals it was designed to obtain a low calcium-low phosphorus ration, a high calcium-high phosphorus ration, a low calcium-high phosphorus ration, and a high calcium-low phosphorus ration. Blood meal replaced cottonseed meal in the ration of two groups in order to obtain a low phosphorus ration.

Procedure

Fifteen typical dairy animals comprising 10 Jersey heifers 6-8 months of age and 5 milking cows were obtained from Tangipahoa Parish. The heifers were grade animals that had been allowed to graze on upland piney woods areas. All the animals were negative to standard tests for tuberculosis and Johne's disease. Native mixed grass hay, low in calcium and phosphorus content, from an unfertilized field was also obtained in this area, and the grain feeds were purchased from dealers in Baton Rouge.

The animals were divided into five groups, each containing two heifers and a milking cow. The basal ration consisted of native mixed grass hay, and a grain mixture of one part cottonseed meal plus three parts corn, or one part blood meal plus four parts corn, and salt. Based on Morrison's digestibility tables (10), the basal ration with cottonseed meal contained 13.72 per cent digestible protein and 77.62 per cent total digestible nutrients, while the blood meal basal ration contained 19.74 per cent digestible protein and 78.40 per cent total digestible nutrients. There were two groups receiving the blood meal basal ration; the ration of one of these was supplemented with calcium as oyster shell flour. The other three groups received the cottonseed meal basal ration. One of these groups received a phosphorus supplement in the form of sodium dihydrogen phosphate ($NaH_2PO_4 \cdot 2H_2O$), the other a calcium and phosphorus supplement in the form of steamed bone meal (calcium 19 per cent, phosphorus 12 per cent).

The basal ration was adjusted to allow 10 to 20 per cent above Morrison's standards (10) for digestible protein and total digestible nutrients. The amount of hay consumed at the start was approximately five pounds per animal daily, but was gradually increased to ten pounds intake as the animals' requirements increased and when the animals freshened.

The animals were kept in individual stalls for the first 15 months, and had access to water, sunshine, and salt in a dry lot during the day. After 15 months the animals were kept on a dry lot continuously and given hay ad libitum for 6 additional months along with their daily grain ration.

They were weighed each month on three consecutive days. Monthly blood studies were made at this time. Calcium was determined on citrated blood drawn from the jugular vein by the Clark-Collip modification of the Kramer-Tisdall method (2), inorganic phosphorus by the Fiske and Subbarow method (6) using a Coleman spectrophotometer. After freshening, daily milk weights were recorded and monthly fat tests determined.

Table 3 gives the data on the animals, rations, and general plan of study. Animal No. 7 C in lot I died from enteritis after a few weeks on experiment.

TABLE 3. DATA ON ANIMALS, RATIONS, AND GENERAL PLAN OF STUDY

Lot	Cow No.	Age	Ration	Supplement
I (basal)	5 H 9 H 7 C	heifer heifer cow (died)*	native hay, blood meal, corn, and salt	none
II	6 H 10 H 8 C	heifer heifer cow	native hay, blood meal, corn, salt, and oyster shell flour	calcium
III (basal)	12 H 16 H 14 C	heifer heifer cow	native hay, cottonseed meal, corn, and salt	none
IV	3 4 1	heifer heifer cow	native hay, cottonseed meal, corn, salt, and sodium dihydrogen phosphate	phosphorus
V	11 15 13	heifer heifer cow	native hay, cottonseed meal, corn, salt and bone meal	calcium and phosphorus

*Died within two weeks of enteritis.

Results

The native grass hay fed in this experiment was grown on unfertilized pasture in Tangipahoa Parish. It consisted mainly of carpet grass (*Axonopus affinis*) and sedges. Chemical analyses showed this native grass hay to contain 4.56 per cent protein, 0.29 per cent calcium, and 0.07 per cent phosphorus. These values are much lower than the average reported for good quality hay.

Cottonseed meal, which is the usual source of protein in this area, was a standard grade guaranteed to contain 41 per cent protein. It contained 0.15 per cent calcium, and 0.61 per cent phosphorus. Since a low phosphorus ration was desired, some other source of protein low in phosphorus was required. Blood meal which analyzed 73 per cent protein, 0.56 per cent calcium, and only 0.28 per cent phosphorus was therefore selected. It replaced cottonseed meal in two of the rations, making for a higher percentage of protein and a lower percentage of phosphorus. The cracked corn meal averaged 6.94 per cent protein, 0.05 per cent calcium, and 0.26 per cent phosphorus, which is in line with values reported elsewhere. The analyses of the mineral supplements showed oyster shell flour to contain 95.1 per cent calcium; sodium dihydrogen phosphate, 22.48 per cent phosphorus; and bone meal 19 per cent calcium and 12 per cent phosphorus.

The following table (Table 4) summarizes these figures. The lespedeza hay analyses are included for comparative purposes.

TABLE 4. PROTEIN, CALCIUM, AND PHOSPHORUS ANALYSES OF FEEDS USED IN THE EXPERIMENT

Feeds	Protein	Calcium	Phosphorus
	%	%	%
Native grass hay	4.56	0.29	0.07
Cottonseed meal	41.06	0.15	0.61
Blood meal	73.00	0.56	0.28
Cracked corn	6.94	0.05	0.26
Oyster shell flour	....	95.10	....
Sodium dihydrogen phosphate	....	....	22.48
Bone meal	5.32	19.00	12.00
Lespedeza hay*	12.84	0.75	0.67

*Good quality hay, not fed, listed for comparative purposes only. Unpublished data.

Thus, it can be seen that the poor quality native grass hay was low in protein, calcium, and phosphorus as compared with the lespedeza hay. The cottonseed meal was low in calcium, as was the corn, and the blood meal low in phosphorus. In order to formulate a ration low in calcium, cottonseed meal was the protein used; on the other hand, blood meal was the source of protein for a low phosphorus ration.

Table 5 shows the highest daily mineral intake for the experimental animals during their lactation period, and the calcium-phosphorus ratio of the ration.

Blood Meal Rations

It can be seen from Table 5 that the highest daily mineral levels for the two lactating animals in the blood meal basal group (lot I) were each 16.60 grams of calcium and 9.16 grams of phosphorus with a calcium-phosphorus ratio of 1.8:1; for the three lactating animals in the calcium (oyster shell flour) supplemented blood meal group (lot II) the values were 27.19, 28.60, and 35.20 grams of calcium, and 6.67, 6.67, and 9.16 grams of phosphorus with calcium-phosphorus ratio of 3:1,

TABLE 5. DAILY CALCIUM AND PHOSPHORUS INTAKE AND CALCIUM-PHOSPHORUS RATIO IN FEED OF LACTATING ANIMALS ON CONTROLLED EXPERIMENT

Group	Animal No.	Daily intake of minerals						Ca/P ratio
		Feed		Supplement		Total		
		Ca	P	Ca	P	Ca	P	
		gm.	gm.	gm.	gm.	gm.	gm.	
Lot I								
Blood meal ration	5 H*	16.60	9.16	0	0	16.60	9.16	1.8:1
(basal)	9 H	16.60	9.16	0	0	16.60	9.16	1.8:1
Lot II	6 H	16.60	9.16	12	0	28.60	9.16	3.1:1
Blood meal ration +	10 H	15.19	6.67	12	0	27.19	6.67	4.0:1
Calcium	8 C*	15.19	6.67	12	0	35.20	9.16	3.8:1
Lot III	12 H	29.03	19.32	0	0	29.03	19.32	1.5:1
Cottonseed meal ration	16 H	29.03	19.32	0	0	29.03	19.32	1.5:1
(basal)	14 C	15.33	12.97	0	0	15.33	12.97	1.5:1
Lot IV	3 H	14.52	9.66	0	4.5	14.52	13.50	1:1
Cottonseed meal ration +	4 H	14.52	9.66	0	4.5	14.52	13.50	1:1
Phosphorus	1 C	13.83	4.35	0	6.7	13.83	11.05	1:1
Lot V	11 H	14.52	9.66	9.9	4.5	24.42	14.16	1.7:1
Cottonseed meal ration +	15 H	14.52	9.66	9.9	4.5	24.42	14.16	1.7:1
Calcium and Phosphorus	13 C	14.97	11.20	14.85	6.8	28.97	18.20	1.6:1

*H—heifer, C—cow.

3.8:1, and 4:1. In this experiment there was a low calcium-low phosphorus group, and a high calcium-low phosphorus group.

Cottonseed Meal Rations

For the three animals in the cottonseed meal basal group (lot III) the highest daily calcium intake was 29.03, 29.03, and 15.33 grams, respectively, and 19.32, 19.32 and 12.97 grams of phosphorus with calcium-phosphorus ratios of 1.5:1 (Table 5).

The phosphorus supplemented cottonseed meal group of animals (lot IV) received 14.52 grams, 14.52 grams and 13.83 grams of calcium daily and 13.5, 13.5 and 11.0 grams of phosphorus, respectively, making a calcium-phosphorus ratio of 1:1. The calcium and phosphorus supplemented cottonseed meal group (lot V) received 24.42, 24.42, and 28.97 grams of calcium, and 14.16, 14.16 and 18.20 grams of phosphorus, respectively, making calcium-phosphorus ratios of 1.7:1 and 1.6:1.

The reason for these differences in calcium and phosphorus intakes was variations in the amount of feed fed in order to maintain a 10 per cent increase in total digestible nutrients over Morrison's feeding standards (10).

Growth Relationship to the Rations

The body weights of the animals at the start of the experiment, time of calving and gain in weight are given in Table 6. Figures 1 and 2

TABLE 6. BODY WEIGHT OF HEIFERS AND COWS AT BEGINNING OF EXPERIMENT, AND AT THE TIME OF CALVING, AND GAIN IN WEIGHT

Lot	Animal No.	Weight		Gain	Average gain for heifers only
		Initial	At time of calving		
		Pounds	Pounds	Pounds	Pounds
Lot I	5 H	247	567	320	296
Blood meal ration (basal)	9 H	278	550	272	
	6 H	307	622	315	281
Lot II	10 H	278	525	247	
Blood meal ration + Calcium	8 C	515	695	180	
	12 H	283	719	436	376
Lot III	16 H	278	595	317	
Cottonseed meal ration (basal)	14 C	565	700	135	
Lot IV	3 H	260	618	358	344
Cottonseed meal ration +	4 H	340	670	330	
Phosphorus	1 C	575	565	50	
Lot V	11 H	220	615	395	327
Cottonseed meal ration +	15 H	370	630*	260	
Calcium and Phosphorus	13 C	670	702	32	

*Weight at time of second calving.

present the monthly body weights of the heifers on the various rations to the time of calving.

In general, lots I and II, which received blood meal, showed less gain in weight than the animals in lots III, IV and V, which received cottonseed meal as the main protein source in the ration. The animals on the blood meal rations had some difficulty consuming their feed at first, probably because it was less palatable. The lower gain in weight might be attributed to the above fact or, possibly, to the low phosphorus content of the ration.

Under the conditions of this experiment, gain in weight does not appear to be a good criterion by which to judge results. The heifers in the various groups had different initial weights, and when bred they conceived at periods which varied from animal to animal, and thus some calved earlier than other animals. For example, heifer No. 15 calved after being on the experimental ration for six months, compared to 16 months for heifer No. 12. However, at least one of the animals in each group ranked toward the top in greatest gain in weight, i.e., cow No. 5, 320 pounds; No. 6, 315 pounds; No. 12, 436 pounds; No. 3, 358 pounds; and No. 11, 395 pounds.

Relationship of Rations to Blood Levels of Calcium and Phosphorus

The range and averages for blood plasma calcium and inorganic

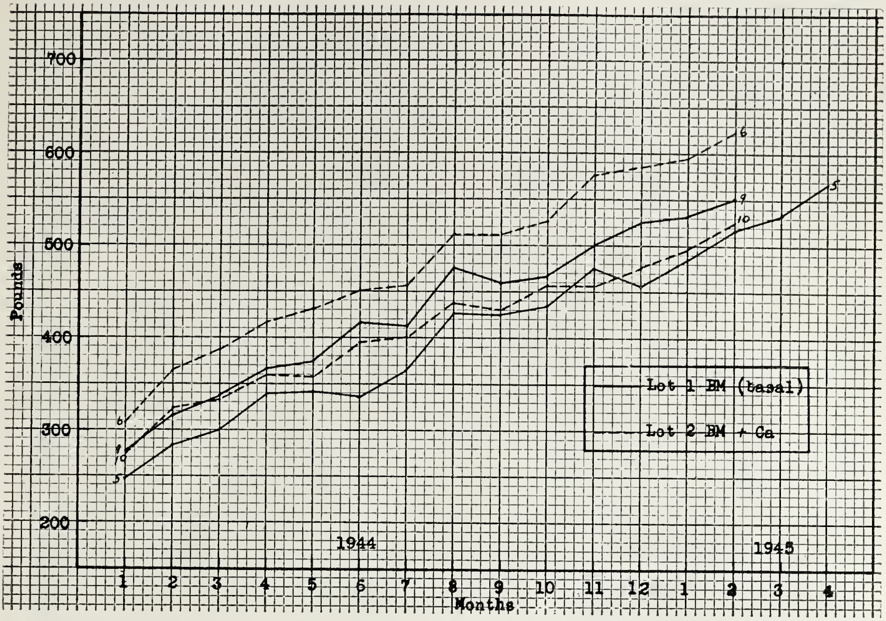


Figure 1.—Body weights of heifers on the blood meal ration to time of calving.

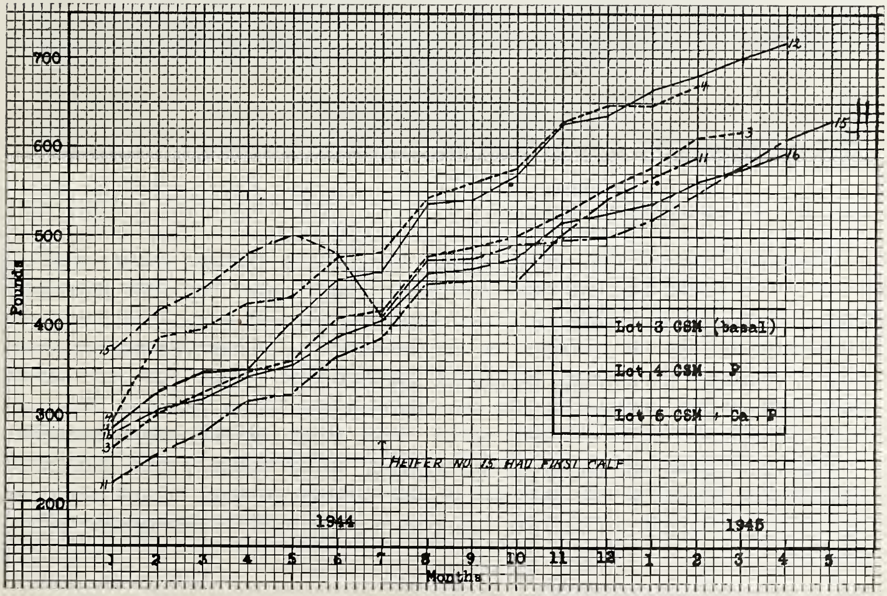


Figure 2.—Body weights of heifers on the cottonseed meal ration to time of calving.

phosphorus values, and calcium-phosphorus ratio in the blood of the experimental animals on the various rations is presented in Table 7.

TABLE 7. Blood plasma calcium and inorganic phosphorus values and calcium-phosphorus ratio of the experimental animals on the various rations

Lot	Animal No.	Range (mg/100 ml. plasma)		Average (mg/100 ml. plasma)		Ratio Ca/P
		Calcium	Phosphorus	Ca	P	
		mg. %	mg. %	mg. %	mg. %	
Lot I Blood meal ration (basal)	5 H	8.40–13.07	4.00–6.67	9.48	5.63	1.68:1
	9 H	9.35–11.75	3.25–6.72	10.41	5.82	1.78:1
	Average	....	....	9.95	5.72	1.74:1
Lot II Blood meal ration + Calcium	6 H	8.87–11.50	3.78–7.57	10.05	5.63	1.78:1
	10 H	9.20–12.22	3.80–5.59	10.46	4.73	2.21:1
	8 C	7.89–12.73	3.50–5.57	10.55	4.74	2.22:1
	Average	....	....	10.35	5.03	2.05:1
Lot III Cottonseed meal ration (basal)	12 H	7.72–11.71	6.06–9.25	9.69	7.44	1.30:1
	16 H	8.44–12.67	6.15–9.19	10.31	7.32	1.40:1
	14 C	8.10–11.16	4.50–7.25	9.86	6.00	1.64:1
	Average	....	....	9.95	6.92	1.44:1
Lot IV Cottonseed meal ration + Phosphorus	3 H	7.76–11.59	5.00–7.51	9.59	6.67	1.44:1
	4 H	8.05–11.29	5.50–7.25	10.21	6.56	1.55:1
	1 C	7.84–11.56	4.00–6.50	9.86	5.76	1.77:1
	Average	....	....	9.89	6.33	1.56:1
Lot V Cottonseed meal ration + Calcium and Phosphorus	11 H	8.23–11.16	4.50–9.44	9.72	7.48	1.30:1
	15 H	8.82–10.97	5.00–7.65	9.44	7.00	1.34:1
	13 C	8.44–12.15	3.07–8.56	9.68	5.64	1.71:1
	Average	....	....	9.61	6.71	1.43:1

Examination of the table shows that these values, while slightly lower than those of "normal" Louisiana dairy cows fed and managed better than average (12), are not significantly different. The calcium-supplemented ration resulted in an increase in blood plasma calcium and a decrease in plasma inorganic phosphorus values (lot II) when compared to the values for the animals on the other rations. The calcium-phosphorus ratio is also wider than those of the other animals.

Figure 3 gives the trend of the average blood calcium and inorganic phosphorus values of the animals in the various groups. There were no significant seasonal variations for plasma calcium or inorganic phosphorus.

Effect of the Rations on Reproduction

Each animal was successfully bred by artificial insemination and pro-

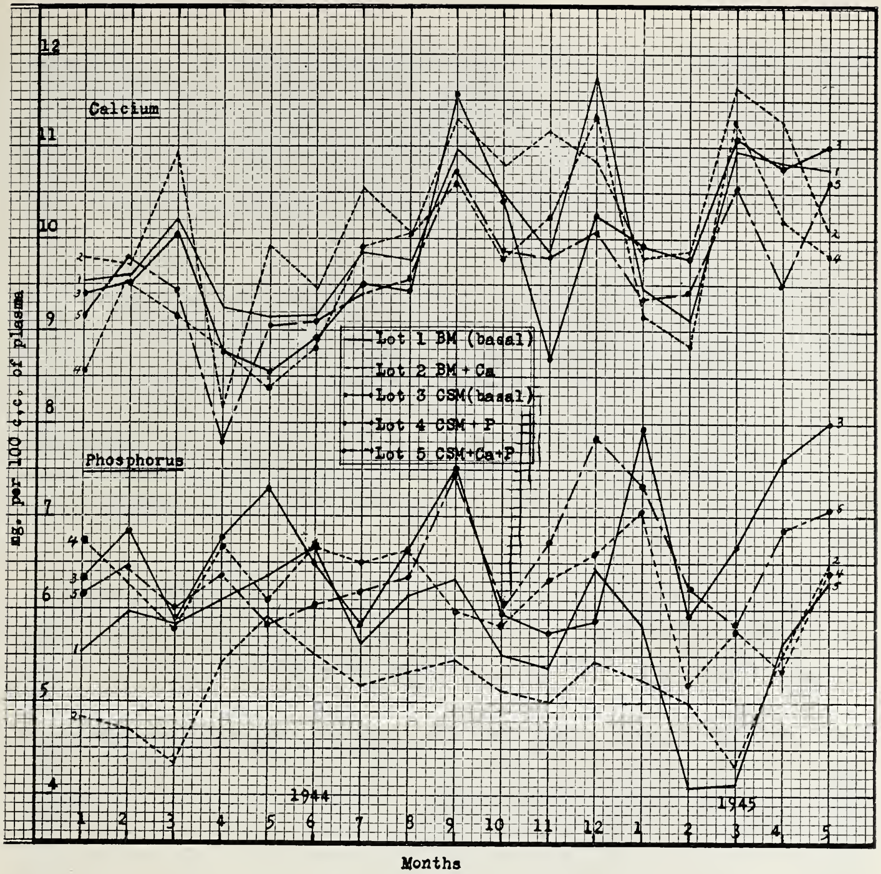


FIGURE 3.—Average calcium and inorganic phosphorus values of animals on the experimental rations.

TABLE 8. BIRTH WEIGHTS AND SEX OF CALVES DROPPED BY EXPERIMENTAL ANIMALS ON VARIOUS RATIONS

Lot	Animal No.	Date of calving	Weight	Sex
			Pounds	
Lot I Blood meal ration (basal)	5 H 9 H	4–15–45 1–31–45	45 45	M F
Lot II Blood meal ration + Calcium	6 H 10 H 8 C	2– 8–45 1–20–45 3–11–45	50 38 50	F F M
Lot III Cottonseed meal ration (basal)	12 H 16 H 14 C	3–15–45 3–19–45 11–15–44	50 53 45	F M F
Lot IV Cottonseed meal ration + Phosphorus	3 H 4 H 1 C	3– 1–45 1–20–45 6–13–45	50 45 55	F F M
Lot V Cottonseed meal ration + Calcium and Phosphorus	11 H 15 H 13 C	3– 9–45 6–20–44 3–18–45	55 52 53	F M F

duced a normal calf. Table 8 gives the birth weights of the calves produced by the experimental animals on the various rations. There was no significant difference in the weight of the calves at birth. Under conditions of this experiment, supplementing the basal rations with calcium or phosphorus, or both calcium and phosphorus had no measureable effect on reproduction or on the birth weights of the calves.

Effect of the Rations on Lactation

There were no marked differences between the various groups in the amount of milk produced during monthly lactation periods. Whether or not they were receiving mineral supplements appeared to make no difference. For lots I and II (blood meal rations), the range of milk fat was from 2.95 to 5.75 per cent. For lots III, IV, and V (cottonseed meal rations) the range of milk fat was from 2.9 to 5.6 per cent. The daily amount of 4 per cent fat-corrected milk produced by the experimental animals from freshening until the termination of the experiment is presented in Table 9.

TABLE 9. AVERAGE DAILY PRODUCTION OF 4 PER CENT FAT-CORRECTED MILK (POUNDS)

Lot	Animal No.	Monthly lactation periods											
		1	2	3	4	5	6	7	8	9	10	11	12
Lot I													
Blood meal	5 H	14.04	13.50	15.59	12.17	....*							
ration (basal)	9 H	9.73	8.88	8.91	9.67								
Lot II													
Blood meal	6 H	11.65	10.09	10.08	10.55	9.55	10.46	....					
ration +	10 H	9.38	7.14	8.45	9.86	7.23	.....						
Calcium	8 C	11.15	9.94	8.75	8.09	7.54	7.15	6.48	6.20	4.97	4.00	3.81	
Lot III													
Cottonseed	12 H	19.81	19.02	16.70	14.48	14.06	11.25	9.21	7.53	7.14			
meal ration	16 H	12.39	13.33	11.90	10.70	11.79	9.38	7.94	6.26	....			
(basal)	14 C	12.81	11.64	9.11	9.58	7.65	6.83	4.86	....				
Lot IV													
Cottonseed	3 H	13.14	10.34	12.70	12.39	13.84	10.42	7.89	7.43	8.42	....		
meal ration +	4 H	12.89	12.08	10.07	10.52	11.59	10.79	9.76	7.98	4.93	....		
Phosphorus	1 C	7.72	9.59	8.84	7.10	9.58	9.25	8.79	6.90	6.22	5.48	3.56	3.73
Lot V													
Cottonseed	11 H	14.59	15.59	13.70	12.37	12.87	12.01	10.64	9.67	6.62	5.92	....	
meal ration +	15 H	9.03	8.37	7.80	6.90	7.18	7.01	6.46	8.00	8.20	7.08	7.71	7.74
Calcium and Phosphorus	13 C	12.52	11.23	9.95	9.65	8.61	6.05	6.15	3.92	2.53	....		

*Taken off experiment.

Discussion

Although the experimental animals on the various rations were in poor physical condition at times and appeared on the borderline of malnutrition, no detectable mineral deficiency could be produced on a ration consisting of poor quality native grass hay, cottonseed meal or blood meal, corn, and salt. Supplementing this ration with calcium or phosphorus, or both of these minerals, did not result in any observed advantage with regard to growth, blood values for calcium and inorganic phosphorus, weight of calves, or milk production. Possibly heavier milking cows might have shown a difference.

A comparison of the daily calcium and phosphorus intake recommended for lactating dairy cattle by the Committee on Animal Nutrition of the National Research Council (3) and the actual calcium and phosphorus intake for the lactating animals on the controlled experiment is presented in Table 10. The actual mineral intake for calcium and phosphorus for lot I is below that recommended for the animals producing a definite amount of milk; the phosphorus intake of lot II is below that recommended; the calcium and phosphorus intake of lot III is fairly close to the amounts recommended; while lot IV is low in both calcium and phosphorus; and lot V is low in phosphorus when compared with the recommended values. Under conditions of this experiment it appears that lactating dairy cattle can function normally on

TABLE 10. RECOMMENDED DAILY CALCIUM AND PHOSPHORUS INTAKE, AND ACTUAL CALCIUM AND PHOSPHORUS INTAKE FOR LACTATING ANIMALS ON CONTROLLED EXPERIMENT

Lot	Animal No.	Weight	Milk	Daily mineral intake			
				Recommended		Actual	
				Ca	P	Ca	P
		lbs.	lbs.	gm.	gm.	gm.	gm.
Lot I Blood meal ration (basal)	5 H	600	14	29	21.8	16.60	9.16
	9 H	600	10	25	19	16.60	9.16
Lot II Blood meal ration + Calcium	6 H	600	11	26	19.7	28.60	9.16
	10 H	500	10	24	18	27.19	6.67
	8 C	700	11	26	19.7	35.20	9.16
Lot III Cottonseed meal ration (basal)	12 H	700	17	32	24	29.0	19.0
	16 H	600	11	26	19.7	29.0	19.0
	14 C	700	9	25	19	15.3	13.0
Lot IV Cottonseed meal ration + Phosphorus	3 H	600	12	27	20.4	14.5	13.5
	4 H	700	12	27	20.4	14.5	13.5
	1 C	565	10	24	18	13.8	11.0
Lot V Cottonseed meal ration + Calcium and Phosphorus	11 H	600	14	27	20.4	24.42	14.16
	15 H	600	10	25	19	24.42	14.16
	13 C	700	9	25	19	29.97	18.20

much lower intakes of calcium and phosphorus than recommended without exhibiting detectable symptoms of calcium or phosphorus deficiency.

Theiler, Green, and DuToit (15) state that when calcium is low it is probable that a relatively high proportion of phosphorus may facilitate the absorption of calcium and thus reduce the risk of calcium starvation. When phosphorus is low a relatively high calcium intake may reduce the absorption of phosphorus and in this way increase the danger of aphosphorosis.

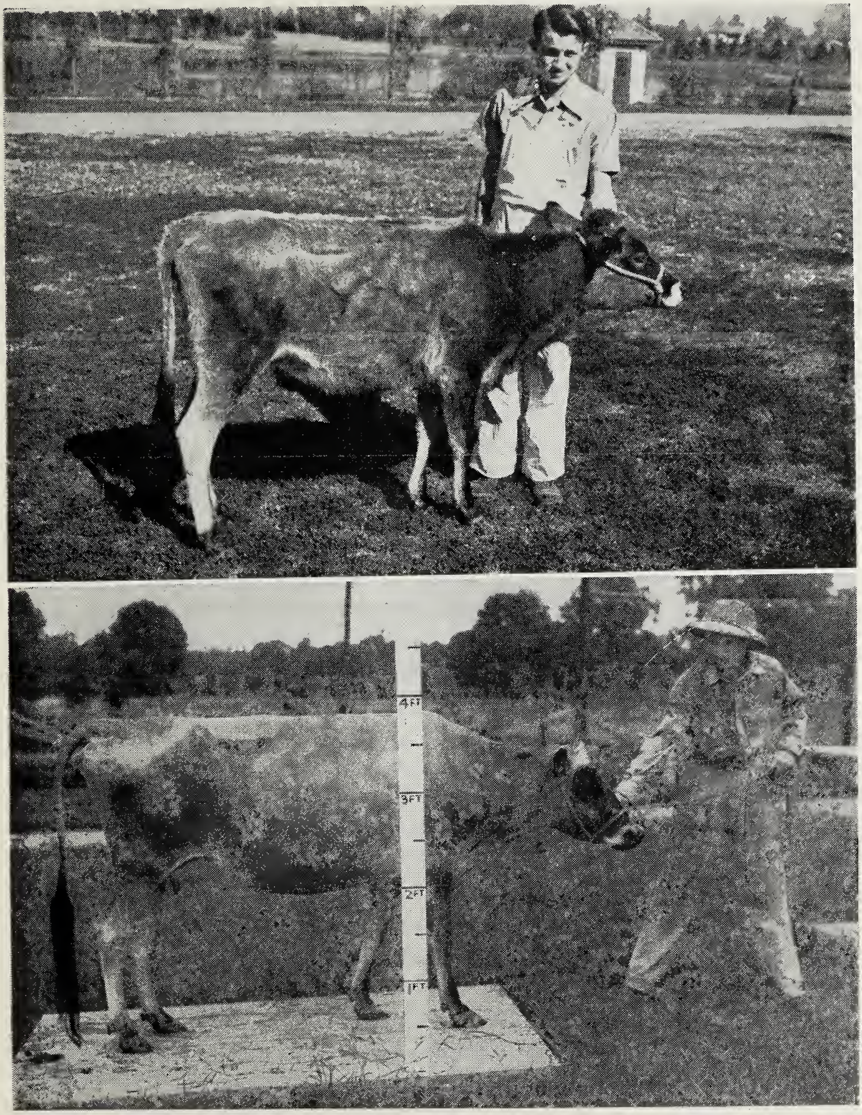
Only the report by Becker, Neal, and Shealy (1) of the Florida Station has been published regarding the effect of calcium deficiency upon dairy cows. These investigators reported bone fractures and low milk production in the Station herd on a ration in which home-grown roughages low in calcium content were fed. Supplementing the ration with 2 per cent of bone meal resulted in an increase in milk production and an increase in bone strength. (Some of the animals were given five pounds of alfalfa hay.) Since bone meal contains both calcium and phosphorus, it is questionable as to whether calcium *per se* was the only mineral responsible for the increase in milk production. The calcium content of the pasture crops consumed by the cows was not taken into account either.

Phosphorus deficiency, on the other hand, is known to occur in many regions (15). Forage is low in phosphorus when produced on phosphorus-deficient soil. Since the phosphorus requirements are high in the lactating cow, phosphorus must be present in adequate amounts. In feeding a grain mixture containing a protein-rich meal, the phosphorus requirements are usually met because of the high phosphorus content of the meal. If no grain mixture or phosphorus supplement is fed, symptoms of phosphorus deficiency such as poor food consumption, low milk yield, and marked inhibition of oestrum can be expected to appear.

In our investigation the animals on the poor-quality, native grass hay, which could be described as a calcium and phosphorus deficient roughage, did not improve by the feeding of calcium and phosphorus mineral supplements.

The ratio of calcium to phosphorus in the feed also had no significant part in this experiment. In Table 5 the calcium-phosphorus values of the feed for the various groups were 1:1, 1.5:1, 1.8:1, 3:1, and 4:1. Experimental evidence with respect to the optimum calcium-phosphorus ratios for growth of calves and heifers is somewhat meager. Lamb and co-workers (9) found that a ration having a calcium-phosphorus ratio of 6.5:1 was satisfactory for raising dairy calves. DuToit, Malan and Groenewald (4) in South Africa fed rations containing calcium-phosphorus ratios of 5.45:1 and 1.43:1 to two groups of calves and found no appreciable difference in rate of growth for a nine-month period. It appears that the availability of calcium and phosphorus in the ration is more important than the ratio of these two minerals.

The monthly blood analyses for plasma calcium and inorganic phosphorus for the individual experimental animals showed a wide range of variation throughout the experimental period. Calcium ranged from 7.72 mg. per cent to 13.07 mg. per cent and inorganic phosphorus from 3.07 to 9.44 mg. per cent. The average values for the various groups ranged from 9.61 to 10.35 mg. per cent for calcium, and 5.03 to 6.92 mg. per cent for inorganic phosphorus. These variations are not any wider



One of the animals on the blood meal basal ration, at start of experiment (upper photo) and at end of experiment (lower photo).

than those reported for better-than-average-fed "normal" Louisiana dairy cows by Rusoff and Piercy (12).

It seems that the concentration of blood calcium in cattle is not influenced readily by dietary calcium. Some investigators, Theiler *et al* (15), Greaves *et al* (8), and Weber and associates (16), have reported that it is difficult to raise the concentration of blood calcium by feeding high calcium compounds. On the other hand, Fitch and co-workers (7) have shown that it is more difficult to lower blood calcium by feeding a ration low in calcium intake.

In this experiment, supplementing the basal ration with calcium (oyster shell flour) resulted in a slightly higher average plasma calcium level, 10.35 mg. per cent, as compared with 9.95 mg. per cent, the average value of the unsupplemented group. The experimental animals showed abnormally high inorganic phosphorus blood values at various times throughout the experiment (up to 9.44 mg. per cent) resulting in a blood calcium-phosphorus ratio of 1:1, but no definite conclusion could be drawn from this.

The low quality native hay in the experimental ration must have supplied a sufficient amount of available calcium, while the grain mixture of meal, corn and salt supplied adequate phosphorus. Therefore, it appears from the experimental data on hand that the customary dairy feeding practices in Louisiana, even when poor quality hay is fed, will probably not result in a detectable calcium or phorphorus mineral deficiency.

SUMMARY AND CONCLUSIONS

(1) This experimental study was designed to find out whether malnutrition of dairy cows in Louisiana was due to a natural deficiency of calcium or phosphorus and whether a mineral deficiency could be produced with dairy calves and cows using Louisiana home-grown feeds fed under winter (dry lot) conditions.

(2) A survey of the calcium and phorphorus levels of the forage and natural feeds in Tangipahoa Parish (milkshed area of New Orleans) disclosed that a low calcium and phosphorus content was present. Fertilization of the pastures with lime and phosphates increased the calcium content of one pasture 267 per cent and phosphorus 192 per cent.

(3) Blood analyses for calcium and inorganic phosphorus of 187 milking cows representing 15 herds in Tangipahoa Parish disclosed a wide range of values for calcium and inorganic phosphorus. Some of the cows had low blood calcium values and/or inorganic phosphorus values, but the average values compared favorably with "normal" values.

(4) A controlled feeding experiment during two years using 10 grade

Jersey heifers and 4 milking cows on a basal ration of poor quality native grass hay, cottonseed or blood meal, corn, and salt, failed to produce any detectable mineral deficiency. Supplementing this ration with calcium (oyster shell flour) or phosphorus (sodium dihydrogen phosphate), or calcium and phosphorus (bone meal) did not show any advantage over the basal ration when growth records, blood levels, reproduction, and lactation records were taken into account.

(5) Variations in the ratio of calcium to phosphorus in the feed, from 1:1 to 4:1, was of no significant effect in this experiment.

(6) Blood plasma values of individual animals for calcium and inorganic phosphorus showed a wide range of variation. Calcium ranged from 7.72 mg. per cent to 13.07 mg. per cent, while inorganic phosphorus values were from 3.07 to 9.44 mg. per cent. These values, however, are in line with values found for "normal" Louisiana dairy cows. The average blood plasma calcium-phosphorus ratios ranged from 1.4:1 to 2:1, but no significance could be attached to this condition.

(7) All the animals were bred by artificial insemination and had normal calves with no differences noted between groups.

(8) The amount of milk produced by the animals in the various groups was practically the same whether or not mineral supplements were being fed.

(9) It is concluded that a low content of calcium or phosphorus in the feed is not the primary cause of malnutrition of Louisiana milking dairy cows.

(10) The practice of allowing dairy animals to forage for themselves in the upland piney woods areas without having access to improved fertilized pasture or without receiving any grain mixture or hay of any kind most probably results in malnutrition associated with protein starvation, calcium and phosphorus starvation, and lack of total digestible nutrients.

(11) It appears that improper feeding practices and improper management are the primary factors of malnutrition. If dairy animals receive good quality green leafy hays or succulent pastures, and a grain mixture fed according to their lactation records, malnutrition conditions will be avoided.

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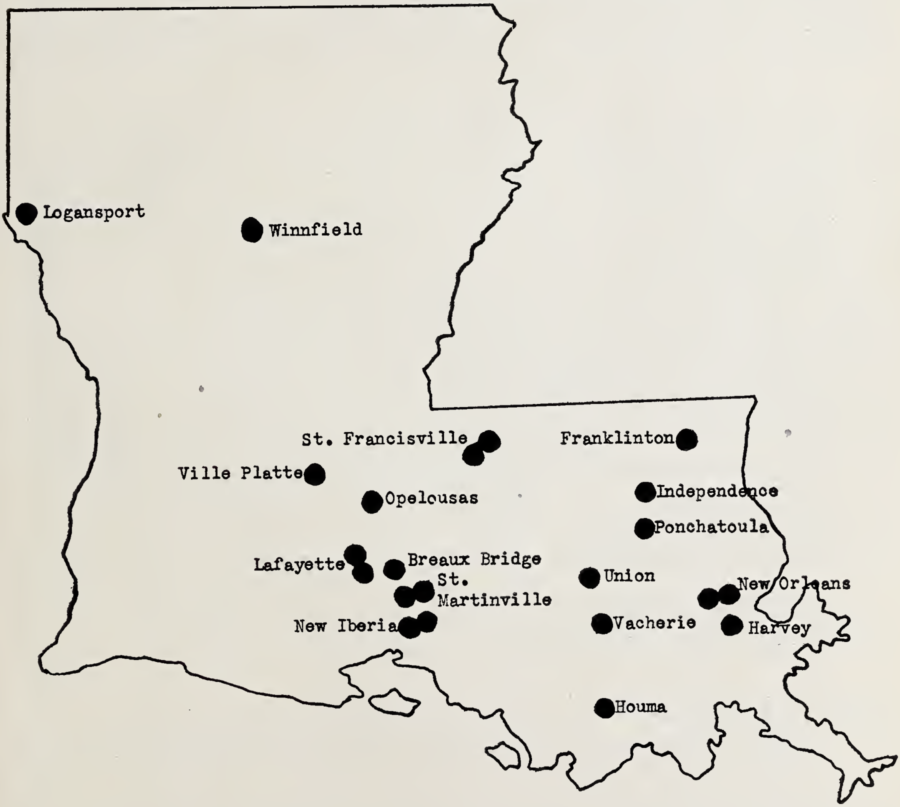
An Economic Study of Commercial Fruit and Vegetable Canneries in Louisiana

By

K. E. Ford and M. D. Woodin

COMMERCIAL FRUIT AND VEGETABLE CANNERIES IN LOUISIANA



Louisiana State University
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Agricultural Experiment Station
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An Economic Study of Commercial Fruit and Vegetable Canneries in Louisiana

K. E. Ford and M. D. Woodin*

INTRODUCTION

An important factor in the financial success of Louisiana farmers is the existence of dependable markets for their products. For fruits and vegetables, canneries have a significant place in the marketing system. Canneries serve to: (1) provide an outlet for fruits and vegetables in areas where no other suitable market is available; (2) prevent heavy losses to growers when the fresh market is temporarily glutted; (3) provide a market for certain low-quality products that are not wanted in the fresh market; (4) stabilize market prices and supplies, thus promoting more orderly marketing.

Purpose of Study

In order to better understand the position of commercial canneries in the marketing of Louisiana fruits and vegetables, and to develop factual information as a basis for appraising the present marketing system and aiding in its constructive development, an economic study of commercial fruit and vegetable canneries was begun in the spring of 1946. An earlier study by the Department of Agricultural Economics of the Louisiana Agricultural Experiment Station, made in 1941, was undertaken primarily to determine the capacity of commercial processing plants in the state and the nature of their operations.[1] The 1941 survey served as a background for the present study. This report presents the findings of the 1946 study and shows changes in the Louisiana fruit and vegetable canning industry during the war years.

Specific objectives of this study were:

1. To determine the number, location, and nature of operations of commercial fruit and vegetable canneries in Louisiana, and the raw products processed by them.

2. To ascertain the quantities of the raw products purchased, prices paid growers, and the costs of the raw products to the canneries of the state.

3. To determine the nature and the extent of the canned fruit and vegetable output, prices received for canned goods, and returns for the pack.

4. To obtain other information regarding operations of the commercial fruit and vegetable canneries of the state; such as, (a) methods of

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* Appreciation is expressed for the cooperation and assistance received from the operators of the commercial fruit and vegetable canneries of the state: the officials of can manufacturing companies; and to Dr. B. M. Gile and to Dr. Julian C. Miller of the Louisiana Agricultural Experiment Station, who offered many helpful suggestions.

[1] K. E. Ford and R. A. Ballinger, *Commercial Processing of Fruits and Vegetables in Louisiana,* (Department of Agricultural Economics, Mimeographed Circular Number 27: Baton Rouge, Louisiana; Louisiana Agricultural Experiment Station, June, 1942).

obtaining raw products; (b) methods of distribution of the canned products; (c) installed canning capacity; (d) relations between growers and canners; (e) seasonality of operations; (f) labor requirements; (g) factors related to success and to failure in the canning industry.

Source of Data

Most of the data were obtained by personal interviews with the operators of commercial canneries in Louisiana. Other data were obtained from: (a) officials of can manufacturing companies; (b) reports and publications of the United States Department of Agriculture and the National Canners Association; and (c) reports on similar studies in other states.

This report is limited to those canning plants that purchase raw fruits and vegetables directly from growers and produce dealers. Plants engaged only in reprocessing or in processing by methods other than canning are not included.

FRUIT AND VEGETABLE CANNERIES

Location of Canning Plants

Twenty-two commercial canneries packed fruits and vegetables in Louisiana in 1946. The location of these canneries is shown on the cover page. Some of these did not operate during all of the war years.

The canneries operating in recent years are located in 16 parishes. These canneries are largely concentrated in three sections of the state, but not more than three are in any parish. Two are in the northern section, one having been established in 1945. Nine canneries are in the Bayou Teche section around New Iberia and Lafayette. Two of the new canneries that began operations with the 1946 pack are located in this area. Eight canning plants are located east of the Mississippi River. One of these started operations in 1945, and three in 1946. The three other canneries in the state are located at Harvey, Houma, and Vacherie.

Age of Canning Plants

Eight canneries in the state have been organized more than 15 years (Table 1). Seven have been established from 5 to 14 years. Two canneries started operations in 1945, and five in 1946.

TABLE 1. Age of Commercial Fruit and Vegetable Canneries, Louisiana, 1946

Years of age	Number of canneries
Less than 1 year	5
1 to 5	2
5 to 9	4
10 to 14	3
15 to 19	4
20 or more	4
Total	22

A few canning plants, located mainly in South Louisiana, were originally established to process sea foods. Later fruit and vegetable canning was begun as a supplementary enterprise.

The establishment of seven new canneries during 1945 and 1946 is greater than the usual addition to the canning capacity of the state for a two-year period. This is partly accounted for by the increasing importance of sweet potato production. Six of the new canneries have sweet potato canning as their main enterprise, and are integrated with other operations such as dehydrating and sugarcane syrup manufacturing.

Canning Capacity

The daily capacity of Louisiana canneries was determined by obtaining estimates on each cannery's experience with the 1945 pack of the three major vegetables. Six canneries had the capacity to pack a total of 8,800 cases of okra per day (Table 2).[2] Sixteen thousand cases was the capacity of seven canneries packing snap beans, and 11,200 cases the capacity of eight canneries packing sweet potatoes.

The annual capacity of Louisiana canneries is difficult to determine because some plants pack several products whose seasons overlap. A cannery may be able to pack 800 cases of sweet potatoes or 1,000 cases of mustard greens per day; however, the canning seasons of these two commodities are about the same, so that this cannery could not pack both products at the same time with its present equipment and labor.

TABLE 2. Commercial Canning Capacity for Three Major Vegetables, Louisiana, 1945

Vegetable	Canneries reporting* (Number)	Total daily capacity (Standard cases)
Okra	6	8,800
Snap beans	7	16,000
Sweet potatoes	8	11,200

* Includes only canneries handling these products in 1945.

The supply of raw products during the season is a second factor affecting total capacity. This supply may not be received in a manner that allows the plant smooth and continuous operation. An oversupply may be had at one time and an undersupply at another. If a cannery is to maintain its rated capacity throughout the season for any one product, deliveries must be regular.

Canning Seasons

A cannery should have a reasonably constant supply of raw products throughout the year in order to operate efficiently. Continuous operation permits greater economy in the use of labor and equipment and reduces per unit overhead costs.

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[2] Cans of various sizes and numbers per case are used by commercial canneries. In order to facilitate comparisons in this study, actual cases have been converted to standard cases containing 24 No. 2 cans. Conversion factors from the National Canners Association were used in making calculations. Unless otherwise noted, the term "case" in the remainder of this report refers to standard cases.

The harvesting of sweet potatoes, okra, and snap beans is so timed that canneries are able to plan their operations to have one major commodity to pack during each month of the year. Sweet potatoes are packed in more of the months because of the longer harvesting period and the relative ease of storing until needed for processing. The canning of sweet potatoes in Louisiana begins in July and continues into April (Figure 1). The volume canned during the spring and summer months is relatively small. Few sweet potatoes are harvested for processing in July and August, and canning of sweet potatoes is a secondary operation during those months for many canneries. The supply is almost exhausted by April and sweet potato canning is limited, although often it is the major activity at some canneries because the supply of other commodities is low at this season.

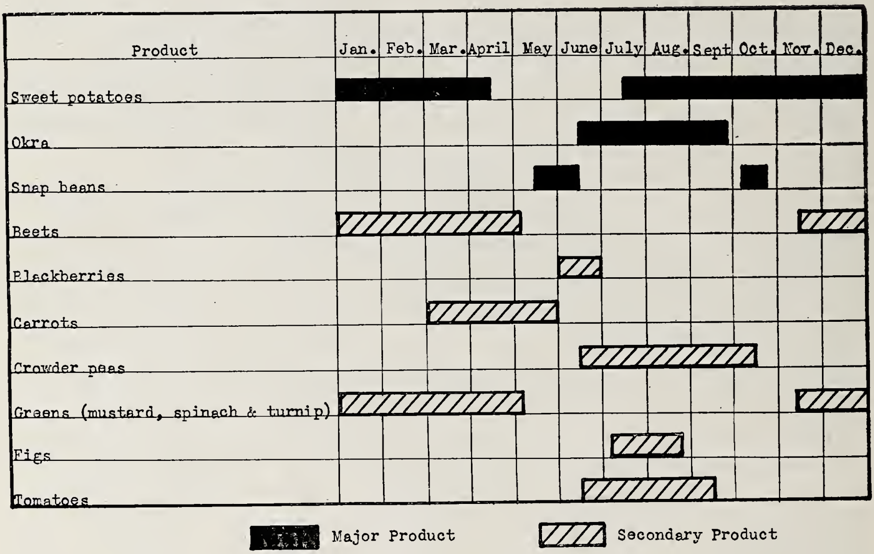

FIGURE 1. Canning Season for Various Fruits and Vegetables, Louisiana, 1945.

Snap bean canning becomes the major operation in May and is usually completed in June. The fall snap bean pack is relatively small because most of the production goes to the fresh market. Just as the spring snap bean pack ends, okra is ready for harvesting and is the major commodity canned during July, August, and early September. Okra becomes secondary to sweet potatoes in September and the pack is rather small that month as compared with sweet potatoes.

The winter greens such as mustard, spinach, and turnip greens are canned at the time sweet potatoes are processed and are secondary to the sweet potato pack. Canning of winter greens does not interfere to any great extent with the sweet potato pack, and often works in well with sweet potato operations. The winter greens pack is not very large in Louisiana. Beets and carrots are canned about the same months that winter greens are packed.

Blackberries, crowder peas, figs and tomatoes are secondary commodities packed during the summer months by the canneries in the southern part of the state. The canneries in North Louisiana have been exclusively devoted to tomato canning and have operated largely to salvage the surplus tomatoes not taken by the green-wrap market. These canneries process only a small part of the total pack of canned fruits and vegetables in the state.

Cannery Labor

The eight canneries packing sweet potatoes employed 850 part-time workers to handle the 1945 sweet potato pack (Table 3). Six canneries packing okra estimated that a total of 350 part-time employees were used for the okra pack. Seven hundred fifty part-time employees were used by seven canneries during the snap bean season. Maintaining an adequate supply of labor is one of the greatest problems encountered by commercial canneries. The shortage of labor in the entire industrial system during the recent war and the seasonal nature of cannery operations are the reasons for this shortage of cannery workers. Persons desiring full-time employment can not depend upon the seasonal nature of the labor needs of the canneries. Canneries have two alternatives, either to employ persons desiring only seasonal employment or to maintain a larger labor force than necessary during slack periods. Key or supervisory employees are given full-time employment whenever possible. Other labor necessary only during actual canning operations consists largely of women desiring part-time jobs. Two canneries depend almost entirely upon farm women as a source of labor. In order to obtain labor, several canneries had to provide daily transportation from distances ranging up to 30 miles.

TABLE 3. Number of Part-time Employees in the Commercial Canning of Selected Vegetables, Louisiana, 1945

Vegetable	Canneries reporting	Total part-time employees
Okra	6	350
Snap beans	7	750
Sweet potatoes	8	850

RAW PRODUCTS FOR CANNING

Canning Crop Production Areas

The St. Francisville and Opelousas districts are the areas that furnished almost the entire supply of sweet potatoes needed by Louisiana canneries to pack more than one-half million cases in 1945. One cannery located within the St. Francisville area and three plants in the southern part of the Opelousas district packed sweet potatoes in 1945. A fifth cannery packing sweet potatoes in 1945 is located a few miles south of the Opelousas district. These five canneries haul the greater part of their sweet potatoes only relatively short distances. The remaining three canneries packing sweet potatoes in 1945 obtained a small part of their sweet potatoes locally, but a larger proportion had to be hauled greater distances than those for the canneries located within the two principal sweet potato growing areas. A few canneries obtain a limited part of their supply from the Oak Grove district in West Carroll Parish.

Snap bean production for commercial canning in Louisiana is largely concentrated in a small area around four canneries in the Teche section. Two of these canneries are in St. Martin Parish and two in Iberia Parish. Canneries in this section obtained snap beans from distances ranging up to 45 miles, although the major part of the supply came from areas nearer the plants. Terrebonne Parish was the main source of snap beans for the canneries at Houma and Harvey. Growers supplying the Houma cannery are within 20 miles of the plant while those supplying the Harvey cannery are as far as 60 miles away. The cannery at Franklinton obtained snap beans grown in Washington Parish, and from Mississippi growers within 40 miles of the plant.

Okra production for commercial canning was confined to almost the same areas as snap beans in 1945, except that one additional cannery in the Teche section packed okra, and the canneries at Houma and Harvey did not pack okra in 1945. The supply of okra for the cannery at Franklinton was grown in Washington Parish, 20 miles or less from the cannery.

Canning Crop Acreage

More than three times as many acres were required to produce the sweet potatoes processed by commercial canneries in Louisiana in 1945 than for all other vegetables combined (Table 4). Sweet potatoes was the only crop showing an increased acreage for canning from 1941 to 1945. Nearly six thousand acres were needed to meet canning requirements in 1945, or almost twice that of 1941. Two canneries specialized in sweet potatoes in 1945, and sweet potatoes was the chief commodity canned in six other plants. Several canneries bought only No. 2 sweet potatoes, which meant that the total production from any specific acre was not delivered to a cannery. A greater acreage is required to produce a given quantity of No. 2 sweet potatoes for canning than if the total production of an acreage is delivered to the canneries.

Of the other four vegetables shown in Table 4, decreases ranging from 50 to 80 per cent of the 1941 acreage were found in the acreage necessary to produce the volume delivered to canneries in 1945. As pointed out above, fewer canneries packed these products in 1945 than in 1941, and the volume was lower because of labor and material shortages, government restrictions, and a favorable fresh market.

The acreage shown in Table 4 is the acreage that would be required to produce the volume delivered to the canneries, and is based upon the average yield per acre obtained in production for the fresh market and the tonnage purchased by canneries. When using this method of determining canning crop acreage it is necessary to assume that the yield per acre is the same in production for the fresh market as for canneries, and that the same quality of produce is delivered to the canneries as to the fresh market. Neither assumption is correct, and sweet potatoes will be used to illustrate this point.

TABLE 4. Acreage Required to Supply Commercial Canneries with Vegetables for Processing, Louisiana, 1941-1945*

Year	Sw't P'toes (acres)	Snap beans (acres)	Tomatoes (acres)	Spinach (acres)	Beets (acres)
1941	3,000	2,400	600	1,200	500
1942	1,000	2,000	300	500	200
1943	800	1,700	200	**	**
1944	2,100	1,000	200	400	100
1945	5,700	1,000	300	300	100

* Acreage calculated by using tonnage purchased by canneries interviewed and 1941-45 average yield obtained in production of vegetables for market. (See text for discussion.)

** Less than 50 acres.

Canneries often do not buy sweet potatoes on the same grade basis as that used in the fresh market. There is considerable difference in the size requirements for sweet potatoes for the two purposes. The contract used by one cannery specifies that the minimum diameter shall be one and one-third inches but does not specify the maximum size or weight. The United States grade standards for sweet potatoes require that a U. S. No. 2 grade sweet potato must be not less than one and one-half inches in diameter and shall weigh not more than 36 ounces.[3] For higher U. S. grades the minimum diameters are greater and maximum weights are less. Other canneries have size specifications which differ from the one for the above-mentioned cannery and from the U. S. standards for the fresh market. Differences other than size specifications exist for sweet potatoes for the fresh market and for canning.

Deliveries of Raw Products to Commercial Canneries

More than 15,000 tons of the six most important vegetables were purchased by commercial canneries for processing in 1945 (Table 5). This is a slight increase from the 14,000 tons of these vegetables purchased in 1941. The 1944 tonnage was about one-half that of 1941 and less than one-half that of 1945. The smaller deliveries in 1944 than in 1941 and 1945 were due, in part, to the inability of canneries to handle a greater volume for reasons previously discussed, and because of the large volume taken by the fresh market.

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[3] *Fruit and Vegetable Regulations,* (Baton Rouge, Louisiana; Louisiana State Market Commission, May 15, 1945), pp. 121-125.

Almost 12,000 tons of sweet potatoes were delivered in 1945, accounting for 76.6 per cent of the total tonnage of vegetables delivered to canneries. Snap beans was the second most important vegetable in deliveries to canneries in 1941, while okra moved to second position in 1945.

Sweet potatoes is the only vegetable that did not decrease in tonnage in 1945 compared with 1941. On the contrary, sweet potatoes purchased by canneries nearby doubled and more than offset declines in other products. Decreases for other vegetables ranged from 39.1 per cent for okra to 71.4 per cent for beets.

TABLE 5. Quantity of Vegetables Purchased for Processing by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Quantity purchased						Per cent change 1941 to 1945
	Thousand tons			Per cent of total			
	1941	1944	1945	1941	1944	1945	
Sweet potatoes	6.2	4.4	11.8	43.4	60.3	76.6	90.3
Okra	2.3	1.0	1.4	16.0	13.7	9.2	-39.1
Snap beans	2.4	1.0	1.0	16.8	13.7	6.5	-58.3
Tomatoes	1.1	.3	.5	7.7	4.1	3.2	-54.5
Beets	1.4	.3	.4	9.8	4.1	2.6	-71.4
Spinach	.9	.3	.3	6.3	4.1	1.9	-66.7
TOTAL	14.3	7.3	15.4	100.0	100.0	100.0	7.7

Raw Product Prices

The average cannery price for sweet potatoes increased from $13 per ton in 1941 to $44 in 1945, a gain of 238.5 per cent (Table 6). Snap beans increased 105 per cent, from $40 to $82 per ton.

The prices which Louisiana canneries paid for raw products were less than the average prices growers received on the fresh market (Table 7). The cannery price for sweet potatoes averaged $1.21 per bushel in 1945, compared with $1.50 on the fresh market. For most vegetables the spread was relatively greater.

Cannery prices for sweet potatoes advanced from $0.36 per bushel in 1941 to $1.21 per bushel in 1945. This was a greater relative increase than that of sweet potatoes in the fresh market, which advanced from $0.72 to $1.50 during the same period. The cannery price in 1941 was 50 per cent of the fresh market price, while in 1945 it was 80 per cent of the fresh market price. This indicates that either the sweet potatoes for canning in 1945 more nearly approached the quality of those for the fresh market or that the demand for sweet potatoes for canning had increased. Prices of snap beans for canning also showed a slight increase in relation to prices in the fresh market.

Cannery prices are not strictly comparable to fresh market prices because the two products are not exactly comparable and are handled differently. It has been noted in a previous section that there is usually a difference in the specifications for a product going to a cannery and for a product for the fresh market. A second factor is the greater expense incurred in preparing a commodity for the fresh market. Vegetables for canning need only be reasonably clean and little or no packaging is required because sales are generally in bulk by weight. Less preparation and packaging represents considerable savings to growers and permits the sale of their products to canneries at lower prices.

TABLE 6. Changes in Prices Paid for Vegetables by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Dollars per ton			Per cent change
	1941	1944	1945	1941 to 1945
Sweet potatoes	13	42	44	238.5
Tomatoes	13	33	28	115.4
Snap beans	40	80	82	105.0
Beets	17	28	28	64.7
Okra	21	28	30	42.9
Spinach	26	33	35	34.6

TABLE 7. Prices of Vegetables for Fresh Market and for Commercial Canning, Louisiana, 1941, 1944, and 1945

Vegetable and use	Dollars per bushel		
	1941	1944	1945
Sweet potatoes			
For market*	0.72	1.45	1.50
For canning	0.36	1.15	1.21
Snap beans			
For market*	1.32	2.30	2.57
For canning	0.58	1.20	1.23
Beets			
For market*	0.50	1.14	1.16
For canning	0.44	0.73	0.73
Tomatoes			
For market*	1.15	3.25	3.75
For canning	0.34	0.87	0.74
Spinach			
For market*	0.60	1.06	1.15
For canning	0.23	0.30	0.32

* *Agricultural Statistics,* (Washington, D. C.: United States Department of Agriculture.)

Another factor to be considered when comparing fresh market prices and cannery prices is that fresh market prices are subject to wide fluctuations within short periods of time while cannery prices are relatively stable through the canning season. The fresh market price most often used in comparisons is an average price, which may conceal a very high price at one time and a price so low at other times that it does not cover the cost of harvesting the product and packaging it for shipment. Spring snap beans were $1.25 per bushel in 1941, and early fall beans $1.65 per bushel.[4] The annual "average price" computed for that year by using the prices for the two seasons and weighing them by production was $1.32 per bushel. By reporting only the annual average price, the high price of snap beans in the fall season is not clearly shown. Daily price fluctuations in the fresh market are even greater than seasonal changes.

It is seldom possible for canneries to obtain sufficient volume when wide margins exist between fresh market and cannery prices. One author concludes: "While canneries cannot meet the fresh-market price when it is high, they offer a much better outlet for vegetables and fruits when there is a glut on the fresh market. If the cannery price more than covers the cost of harvesting and hauling the products to the cannery, it is much better to sell them to the packing plants than to let them rot in the fields."[5] This would not be possible unless there were canneries available to handle the produce when the fresh market was an unfavorable outlet. Few canneries can operate efficiently on fresh market surpluses alone. They must be able to obtain enough volume throughout the season to permit reasonably full operation. Normally, canning plants do not operate at full capacity, so that temporary fresh market surpluses can be handled. Stepp has developed a program recommended for South Carolina in which the growers send to the canneries a quantity of products that would give the canneries from 25 to 35 per cent of their full capacity regardless of the fresh market prices; and when fresh market prices are equal to or below minimum prices previously agreed upon by the canneries, the farmers would deliver all of their production to the canneries.[6] This plan may offer one solution to the problem faced by many Louisiana canneries in obtaining sufficient and steady deliveries. In delivering a fixed proportion of his production to the cannery regardless of the fresh market price, the grower would be assured an outlet at a guaranteed minimum price for his production at times when the fresh market price is low. The gross returns to the growers probably would be more stable under a program of this nature. The cannery would be assured a supply of raw products throughout the season at a price determined even in advance of planting.

Canning Crop Value

Approximately $670,000 were expended by Louisiana canneries to obtain the six most important raw products they processed in 1945 (Table 8). The increase in expenditures was 133.4 per cent over those for

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[4] J. P. Montgomery, *Production, Price, and Value of Selected Crops, Livestock and Livestock Products in Louisiana, 1910-1944,* (Department of Agricultural Economics, Mimeographed Circular No. 49; Baton Rouge, Louisiana: Louisiana Agricultural Experiment Station, Dec. 1945), pp. 32-33.

[5] J. A. Stepp, *An Economic Study of Commercial Fruits and Vegetable Canneries in South Carolina,* (Bulletin 342; Clemson, South Carolina: South Carolina Agricultural Experiment Station, Sept. 1942), p. 28.

[6] *Ibid.,* p. 29.

1941, which amounted to $287,000. Expenditures by canneries for fruits and vegetables have been used in this section rather than the amount paid to farmers because in certain instances canneries do not buy directly from farmers. A considerable volume of sweet potatoes is bought from storage plants. Practically the entire supply of the other commodities is purchased directly from farmers.

TABLE 8. Expenditures for Vegetables for Processing by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Total expenditures						Per cent change
	Thousand dollars			Per cent of total			
	1941	1944	1945	1941	1944	1945	1941 to 1945
Sweet potatoes	82	186	516	28.6	58.1	77.1	529.3
Snap beans	95	78	80	33.1	24.4	11.9	-15.8
Okra	48	28	42	16.7	8.8	6.3	-12.5
Beets	24	7	10	8.4	2.2	1.5	-58.3
Tomatoes	15	11	13	5.2	3.4	1.9	-13.3
Spinach	23	10	9	8.0	3.1	1.3	-60.9
TOTAL	287	320	670	100.0	100.0	100.0	133.4

Because of higher prices paid and a greater volume, expenditures for sweet potatoes increased from $82,000 in 1941 to $516,000 in 1945, an increase of more than 500 per cent. The percentage decrease in expenditures for other vegetables in 1945 over 1941 ranged from about 12 per cent for okra to about 60 per cent for spinach. The decreases were caused by the reduced volume of these products.

Sweet potatoes accounted for 77.1 per cent of the total expenditures in 1945. Expenditures for other products ranged from about one per cent of the total for spinach to 12 per cent for snap beans. Sweet potatoes occupied a relatively lower position in total costs in 1941 than did snap beans, but were seven times as important in 1945.

Purchasing Methods

Louisiana canneries obtain raw fruits and vegetables by purchasing them in the open market and by means of canner-grower contracts. In 1945, five canneries purchased their entire supply of sweet potatoes in the open market; one cannery bought only from contract growers; and two canneries used both methods (Table 9).[7] Sweet potato purchases in the open market were made by plant representatives from growers and storage sheds.

Canner-grower contracts were used by five canneries in purchasing snap beans, and by four canneries in purchasing okra in 1945. One cannery purchased snap beans in the open market directly from growers, and one used both methods. The open market was the source of supply of okra for one cannery, while another purchased from both contract and non-contract growers. Two canneries processed dry beans and dry peas grown in other states and obtained them through commission agents. A part of the supply of beets of two canneries was purchased through commission agents from Texas.

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[7] The term "open market" as used in this study includes all buying and selling activities except those between canneries and the growers with whom they have contracts. Sales made under contracts may be referred to as "closed market" deals.

TABLE 9. Methods Used by Commercial Canneries to Obtain Raw Products, Louisiana, 1945

Product	Number of canneries using			Total
	Open market	Grower contracts	Both methods	
Sweet potatoes	5	1	2	8
Snap beans	1	5	1	7
Okra	1	4	1	6
Beets	1	0	2	3
Spinach	0	1	2	3
Tomatoes	0	1	2	3

Canner-Grower Relations

It is to the advantage of cannery operators to maintain constant contact with the growers either directly or through field men employed by the cannery. However, few canneries employ field men whose main job is to promote a close working relationship between growers and the cannery management. Lack of sufficient volume, failure to recognize the importance of close contact with growers, and the inability to employ well-trained field men often account for this situation. In small canneries the plant manager usually performs the functions of a field man in addition to his other duties.

Duties of a field man employed by a cannery include aiding growers in selecting soils, fertilizers, varieties of crops to be planted, and time of planting. Planting dates are important because of the later effect on deliveries to the cannery. The field man usually handles the distribution of seeds and materials furnished by the cannery and advises growers as to production methods and time of harvesting. Contracts between the cannery and growers are promoted and supervised by the field man, thereby insuring the cannery of deliveries according to the contractual agreement.

The practice of furnishing seed and fertilizer on account to growers has been largely discontinued by Louisiana canneries. The failure of growers to deliver their entire crops to the canneries appears to be the cause for the discontinuance of this practice. Growers have often contracted a specified acreage, accepted seed and fertilizer on account, and then failed to deliver a part or all of their production to the cannery. Canneries have no practical means of forcing collections. Several canneries have lost money in the past because of their inability to collect such accounts. This has been especially true when the fresh market has offered a higher price than the canneries agreed to pay. The general practice in recent years has been for canneries to sell seeds and fertilizer on a cash basis at cost.

Canneries have controlled varieties largely by selling to the growers seeds of varieties they desired to process. This has enabled canneries obtaining most of their supply from contract growers to have one-variety packs. It is most difficult to control variety when purchasing raw products in the open market. Under such conditions the only variety control canneries have is .to refuse to purchase produce not of the desired variety.

Quality is controlled by canneries through the use of contracts which state the specifications for produce they will accept. In open market purchases quality is controlled by refusal to purchase produce that does not meet the desired specifications. Canneries have been rather tolerant in their quality specifications in recent years. Instances were found where produce was accepted well below standard in order to secure sufficient volume and to maintain good relations with growers. It is expected that contractual requirements regarding quality will be more rigidly enforced when supplies for processing become available in greater volume.

THE FINISHED PACK

Commercial fruit and vegetable canneries in Louisiana packed 911,000 cases of fruits and vegetables in 1945 (Table 10). This was the largest pack of any war year, and nearly twice the 1944 output, but 19.4 per cent less than the production in 1941. The pack each year from 1942 through 1944 amounted to about one-half the 1941 pack, with the greatest reduction in 1943.

The sweet potato pack of 551 thousand cases amounted to almost two-thirds of the total fruit and vegetable pack in 1945, as compared

TABLE 10. Quantity of Vegetables Packed by Commercial Canneries, Louisiana, 1941-1945

Vegetable	Quantity packed										Per cent change
	Thousand cases					Per cent of total					
	1941	1942	1943	1944	1945	1941	1942	1943	1944	1945	1941 to 1945
Sweet potatoes	300	103	102	194	551	26.5	19.8	23.4	38.6	60.5	83.7
Snap beans	224	192	164	91	95	19.8	37.0	37.8	18.2	10.0	-57.6
Okra	179	67	76	93	114	15.8	12.9	17.5	18.5	12.5	-36.3
Spinach	83	52	17	22	18	7.4	10.1	3.9	4.4	2.0	-78.3
Beets	69	33	5	18	26	6.2	6.4	1.1	3.6	2.9	-62.3
Tomatoes	44	21	14	12	17	3.9	4.0	3.2	2.4	2.0	-61.4
All others*	231	51	57	72	90	20.4	9.8	13.1	14.3	10.1	-61.0
TOTAL	1,130	519	435	502	911	100.0	100.0	100.0	100.0	100.0	-19.4

* Includes corn, figs, dry peas, fresh field peas, mustard greens, and minor crops which were packed occasionally.

with less than one-third of the total for 1941. Sweet potatoes ranked second to snap beans in 1942 and 1943, but were twice as important as snap beans in 1944, and six times as important in 1945. Two factors responsible for the change in the relative position of sweet potatoes in 1942 and 1943 were the government regulations and restrictions in the uses of tinplate and sugar, and wartime demand for dehydrated sweet potatoes. These same factors also affected the 1944 pack but not to the extent as in 1942 and 1943.

The syrup pack and the solid pack are the two methods of sweet potato canning most extensively used by canneries in Louisiana. The syrup pack has ranged from almost 80 to more than 90 per cent of the sweet potato pack from 1942 through 1945. Demand for this pack, which is ready to serve when removed from the can, appears to be increasing, both actually and relatively to the solid pack. Solid-pack sweet potatoes are largely desired for pastries and similar uses in which additional cooking is necessary.

Second in importance in 1941 was the snap bean pack of 224,000 cases, comprising one-fifth of the total fruit and vegetable pack in Louisiana. Snap beans became the most important product in 1942 and 1943. This resulted because of a greatly reduced sweet potato pack. In 1944 and 1945 snap beans ranked third in volume, exceeded by sweet potatoes and okra.

Yield of Finished Product Per Ton of Raw Material Purchased

There is considerable variation among commodities in the number of cases of finished goods obtained from a ton of raw product. The seven canneries packing snap beans in 1945 obtained 97 cases per ton of snap beans purchased (Table 11). High yields are also common for okra, spinach, and beets. Sweet potatoes and tomatoes have a much lower turnout per ton of raw product processed.

Differences in cannery yield among products are due mainly to differences in losses in preparation and in the ratio of weight to volume. For example, 73 cases of okra were obtained per ton, although losses from trimmings and overly matured pods amounted to 35 per cent of

TABLE 11. Standard Cases Obtained Per Ton of Vegetables Purchased by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Standard cases per ton		
	1941	1944	1945
Snap beans	92	94	97
Okra	79	90	82
Spinach	80	74	73
Beets	48	69	68
Sweet potatoes	48	44	47
Tomatoes	39	35	35

the quantity purchased (Table 12). On the other hand, the losses on sweet potatoes were slightly less than okra, but only 47 cases were obtained per ton. Okra is light in weight relative to its volume, so that the 1,300 pounds of usable product per ton filled a larger number of cans. Sweet potatoes have a relatively low ratio of volume to weight and losses in preparation are large, especially for syrup-packed sweet potatoes.

TABLE 12. Raw Material Losses in Commercial Canning of Vegetables, Louisiana, 1946

Vegetable	Losses per ton purchased	
	(pounds)	(per cent)
Okra	700	35
Sweet potatoes	660	33
Beets	330	17
Snap beans	100	5
Spinach	100	5

Yield of finished goods per ton of raw product varies from one season to another because of differences in the quality of raw products processed. Differences in quality may result from favorable or unfavorable farm production conditions, or from variations in the tolerances of cannery buyers. When supplies of raw products for processing are small because of crop failure or high fresh market prices, products of lower quality are frequently handled by canneries.

Yield per ton also varies among canneries because of differences in type or variety of raw materials processed, the method of canning used, and the efficiency of the individual plants.

Canned Vegetable Prices

Prices received by Louisiana canneries for finished products in 1945 were much higher than in 1941 (Table 13). Increases ranged from 22 per cent for tomatoes to 80 per cent for sweet potatoes. Four of the six major products were up in price in 1945 compared with 1944.

Prices for syrup-packed sweet potatoes have been higher than for the solid-packed type. The average difference in price per case amounted to twenty-one cents in 1941, five cents in 1944, and sixty-five cents in 1945. Syrup-packed sweet potatoes increased from $1.78 per case in 1941 to $3.15 in 1945, a change of 77.0 per cent. Solid-pack prices increased from $1.57 to $2.50, or 59.2 per cent.

Cannery prices for snap beans increased from $1.58 per case in 1941 to $2.44 in 1945, or 54.4 per cent. Most of the increase occurred prior to 1944. Whole-bean prices increased more than cut-bean prices. Canned whole beans are normally higher in price than cut beans, the difference amounting to $0.63 per case in 1945. Costs are usually greater in packing whole beans because a higher quality product is desired and more labor is required in processing.

TABLE 13. Prices Received for Vegetables Packed by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Dollars per standard case			Per cent change 1941 to 1945
	1941	1944	1945	
Sweet potatoes*	1.68	2.81	3.03	80.4
Syrup pack	1.78	2.82	3.15	77.0
Solid pack	1.57	2.77	2.50	59.2
Snap beans*	1.58	2.33	2.44	54.4
Cut beans	1.57	2.21	2.25	43.3
Whole beans	1.82	2.90	2.88	58.2
Okra*	1.60	1.87	1.97	23.1
Cut okra	1.59	1.86	1.97	23.9
Whole okra	1.79	2.43	2.10	17.3
Beets	1.52	2.11	2.12	39.5
Spinach	1.59	2.18	2.11	32.7
Tomatoes	1.64	2.16	2.00	22.0

* Weighted by volume of each type pack sold.

The 1945 price of cut okra averaged $1.97 per case, or almost 24 per cent higher than the 1941 price of $1.59. Whole-okra prices have been higher than prices of cut okra, but the pack of whole okra has been negligible.

Cannery Price Margins

Changes in prices received by canneries for finished goods and changes in prices paid for raw fruits and vegetables from 1941 to 1945 have resulted in wide variations in the margins between prices paid and received (Table 14). Dollar margins increased for all commodities except tomatoes. The dollar margins for sweet potatoes increased from $1.41 per case in 1941 to $2.09 in 1945. Thirty-one per cent of the finished goods price of sweet potatoes was required to pay for the raw product in 1945, as compared with 16.1 per cent in 1941. The raw material cost was $0.27 per standard case in 1941 and $0.94 in 1945, as compared with cannery selling prices of $1.68 and $3.03, respectively.

Both dollar margins and relative margins are important to growers and canners. In general, the ratios of prices received for finished goods to prices paid for raw products by canners decreased from 1941 to 1945, that is, a greater proportion of the price received by canners for canned vegetables was spent for raw products in 1945 than in 1941. Beets showed the only decline; in 1945 the raw material price was 16 per cent of the finished product price as compared to 23 per cent in 1941.

TABLE 14. Relationship of Prices Received for Finished Products to Prices Paid for Raw Vegetables, Louisiana Commercial Canneries, 1941, 1944, and 1945

Vegetable and item	Unit	(Standard case basis)		
		1941	1944	1945
Sweet potatoes				
Price cannery received	$	1.68	2.81	3.03
Raw material cost	$	0.27	0.96	0.94
Cannery margin	$	1.41	1.85	2.09
Part of cannery price to pay for raw material	%	16.1	34.2	31.0
Snap beans				
Price cannery received	$	1.58	2.33	2.44
Raw material cost	$	0.42	0.85	0.85
Cannery margin	$	1.16	1.48	1.59
Part of cannery price to pay for raw material	%	26.6	36.5	34.8
Okra				
Price cannery received	$	1.60	1.87	1.97
Raw material cost	$	0.26	0.30	0.37
Cannery margin	$	1.34	1.57	1.60
Part of cannery price to pay for raw material	%	16.3	16.0	18.8
Spinach				
Price cannery received	$	1.59	2.18	2.11
Raw material cost	$	0.28	0.44	0.48
Cannery margin	$	1.31	1.74	1.63
Part of cannery price to pay for raw material	%	17.6	20.2	22.7
Beets				
Price cannery received	$	1.52	2.11	2.12
Raw material cost	$	0.35	0.32	0.34
Cannery margin	$	1.17	1.79	1.78
Part of cannery price to pay for raw material	%	23.0	15.2	16.0
Tomatoes				
Price cannery received	$	1.64	2.16	2.00
Raw material cost	$	0.34	0.96	0.79
Cannery margin	$	1.30	1.20	1.21
Part of cannery price to pay for raw material	%	20.7	44.4	39.5

The item in Table 14 labeled "Part of cannery price to pay for raw material" could have been correctly labeled "Farmers' share" for several commodities. The "raw material cost" item was often the price that canneries paid directly to growers for vegetables delivered either to the canneries or to receiving sheds operated by canneries. The raw materials cost for sweet potatoes, and in some instances for other vegetables, was not the price that the grower received because canneries did not obtain all their supply from them.

The raw material costs for snap beans and okra more nearly represent prices paid directly to the growers. More snap beans, okra, and spinach were purchased directly from growers than any other vegetable. Some of the beet purchases were made through commission agents. Tomatoes, too ripe for shipment to the fresh market, are sometimes sold to canneries. Some of the plants have sent their trucks to the packing sheds to obtain tomatoes, so not all purchases were made directly from farmers. However, this practice was not followed in 1945.

Returns from Finished Product Sales

Gross returns from the sale of canned fruits and vegetables by commercial canneries in Louisiana amounted to $2,437,000 in 1945 (Table 15). This was an increase of 33.7 per cent over gross returns of $1,823,000 in 1941. The increase resulted from the sharp rise in returns for canned sweet potatoes, since the pack of all other commodities decreased in value.

Sales of canned sweet potatoes amounted to $1,668,000, or more than two-thirds of the gross receipts of canneries in 1945. Snap beans and okra returns, next in importance, were about one-eighth as great.

TABLE 15. Returns from Fruits and Vegetables Packed by Commercial Canneries, Louisiana, 1941, 1944, and 1945

Vegetable	Gross Returns						Per cent change
	Thousand dollars			Per cent of total			
	1941	1944	1945	1941	1944	1945	1941 to 1945
Sweet potatoes	504	546	1,668	27.7	45.1	68.4	231.0
Snap beans	355	212	232	19.5	17.5	9.5	-34.6
Okra	287	174	225	15.7	14.4	9.2	-21.6
Spinach	132	48	38	7.1	4.0	1.6	-71.2
Beets	105	38	55	5.8	3.1	2.3	-47.6
Tomatoes	72	26	34	3.9	2.1	1.4	-53.0
All others*	368	167	185	20.2	13.8	7.6	-49.7
TOTAL	1,823	1,211	2,437	100.0	100.0	100.0	33.7

* Includes corn, figs, dry peas, fresh field peas, mustard greens, and other minor crops which were packed occasionally.

Market Outlets and Sales Policy

The principal marketing channel for Louisiana canneries is through brokers. Nearly all canneries used this outlet in 1945. One cannery sells its entire pack, which was rather limited in size and consisted of only one commodity in 1945, to a wholesale firm.

According to cannery officials, the broker seems to provide a satisfactory sales outlet. Few canneries market their production throughout the year, and an attempt by them to maintain constant contact with the market would probably be more expensive than the brokerage now charged. This fee amounted to three per cent in 1945, except for one cannery which paid five per cent to a broker who provided additional services.

Most sales of finished goods are made during and after the processing season for a commodity. Several canneries do forward selling through their brokers, subject to crop conditions. Some accept orders in advance of the normal planting season of vegetables to be processed.

Brokers handle practically all of the sales promotion done on fruits and vegetables packed by Louisiana canneries, except for the advertising accomplished through cannery labels. About 75 per cent of the total pack in this state was sold under the canneries' own labels. The remaining 25 per cent was sold with the buyer's labels put on by the canneries. A few canneries sold their entire output under their own labels.

The destinations of finished products shipped by the commercial canneries of the state vary widely. Several small canneries ship their packs exclusively intra-state. Their limited operations, both in size of pack and number of commodities handled, does not justify their meeting the requirements necessary to move the pack in interstate commerce.

Canneries with larger packs and a greater variety of products have a much wider area of distribution. Some concentrate sales effort in definite areas. The principal areas of distribution outside of Louisiana are on the Pacfic Coast and in the Middle West.

SUMMARY, CONCLUSIONS AND OUTLOOK

Commercial canneries are important to many fruit and vegetable growers in Louisiana because they serve as a market for local produce and are a stabilizing influence in the marketing system.

Twenty-two commercial fruit and vegetable canneries operated in the state in 1946. Seven of these were established during 1945 and 1946.

Restrictions on the use of tinplate and other materials, scarcity of labor, and relatively high prices for fresh produce caused Louisiana canneries to reduce the size of their pack during the war. Production in 1945 amounted to 911,000 cases compared with 1,130,000 cases in 1941. The packs in 1942, 1943, and 1944 were less than one-half of the 1941 production.

One of the most important developments in the canning industry of the state during recent years has been the great increase in the production of canned sweet potatoes. This pack increased from 300,000 cases in 1941 to 551,000 cases in 1945, a gain of 83.7 per cent. Sweet potatoes made up 60.5 per cent of the total canned fruit and vegetable pack in 1945. Seventeen canneries are expected to pack sweet potatoes during the 1946-47 season, and the production will likely exceed that of 1945.

Okra and snap beans were the other leading vegetables canned in 1945. Beets, spinach, tomatoes, and winter greens accounted for most of the remainder. Fruits, mainly figs, are a negligible part of the total pack of canneries.

Louisiana canneries have the equipment to handle a much greater volume of all raw products than they have processed in the past. Seven canneries had a capacity of 16,000 cases of snap beans per day in 1945, but packed only 95,000 cases during the entire season. This amounted to only six day's production at full capacity, although the snap bean canning season starts in May and ends in June, a period of about 40 days.

Prices paid by canneries for fruits and vegetables for processing increased considerably from 1941 to 1945. Sweet potato prices increased from $13 per ton in 1941 to $44 in 1945, a gain of 238.5 per cent. Price increases for other vegetables ranged from 24.6 per cent for spinach to 115.4 per cent for tomatoes.

Total expenditures for the six most important vegetables purchased by canneries amounted to $670,000 in 1945, an increase of 133.4 per cent over the $287,000 expended in 1941. The greatest increase in expenditures was for sweet potatoes, a change from $82,000 in 1941 to $516,000 in 1945.

Increases in prices received by canneries for finished goods in 1945 over 1941 ranged from 22 per cent for tomatoes to 80.4 per cent for sweet potatoes.

Dollar margins between prices paid and prices received by canneries increased from 1941 to 1945 on all products except tomatoes. However, since raw product prices increased relatively more than canned goods prices, a greater proportion of the finished goods price was required to purchase the raw product in 1945.

The total returns to canneries for the finished pack was $2,437,000 in 1945, or 33.7 per cent higher than the 1941 returns of $1,823,000. However, all individual packs decreased in total returns during this period except sweet potatoes. The returns for canned sweet potatoes amounted to $1,668,000 in 1945. This was an increase of 231.0 per cent of the 1941 returns of $504,000.

Canneries obtain most of their products from nearby growers either delivered to the plants or at country receiving points and storages. About half of the tonnage of sweet potatoes processed is secured from storage houses located in the sweet potato growing districts.

Only a few canneries employ full-time field men to maintain contact with growers and to supervise the field operations of the canning plants. Some plant operators feel that their businesses are too small to justify employing a full-time field representative, and others report the scarcity of trained personnel.

Canneries usually market their finished products through food brokers. The major part of the pack is identified by canneries' labels, although buyer's labels are used to some extent.

In order for the fruit and vegetable canning industry of Louisiana to enjoy greater prosperity and to become a more stable and profitable market for locally-grown produce, several rather serious handicaps need to be overcome. One important problem is the very short and interrupted canning season resulting from the inability of canneries to obtain a continuous supply and sufficient volume of raw products. Canneries are attempting to meet this problem in several ways: (1) by increasing the variety of fruits and vegetables handled, such as adding sweet potatoes; (2) processing products other than fruits and vegetables, such as sea foods and sugar-cane syrup; (3) combining canning with other processing enterprises, such as quick-freezing and dehydrating; (4) encouraging a larger acreage of truck crops locally; (5) drawing raw products from a wider area; (6) growing a portion of their own raw products.

A second problem of canneries is that of maintaining a full, well-trained labor force. This problem would become less acute with a larger volume of processing during a longer season. Canneries would benefit through lower labor recruiting and transportation costs and by the greater efficiency of better-trained employees.

A third problem of cannery officials in Louisiana, and elsewhere, is the failure of growers to abide by the provisions of grower-canner contracts, especially the failure to make deliveries to canneries when fresh market prices exceed contract prices. On the other hand, when fresh market prices are relatively low, growers frequently are dissatisfied with the grading and receiving practices of canners. This problem can be partially solved by improved contractual agreements and by better canner-grower relations in general. A program has been developed in South Carolina whereby growers agree to deliver a specified portion of their production to the cannery at a predetermined price. The cannery agrees to accept the entire crop at this price, provided it equals or exceeds the fresh market price. If the fresh market is more favorable, growers are free to sell the uncontracted part of their crop wherever they choose. This assures the cannery of a minimum supply of produce and guarantees the growers a minimum price for their entire crop. Under such a plan, it is almost necessary that the cannery have a full-time field man to supervise the delivery of produce. A field man can do much to improve contractual relations, to the benefit of both canneries and growers.

Yield per acre for most canning crops is low in Louisiana compared with the yield in the more important production areas of other states. Much research and experimental work has been done by horticultural workers in order to develop varieties of crops that yield well in Louisiana and provide produce of the quality and type suitable for canning. Those products in which Louisiana has a comparative advantage at present probably should receive major emphasis in programs for the improving of varieties, processing methods, and consumer demand. Included in this category are sweet potatoes, okra, snap beans, figs, peppers, and sugar-cane syrup.

To solve these problems will require the best efforts of cannery officials, farm leaders, and agricultural extension and experiment station workers.

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